 pardations and you are finished.”

Software tools integration has con-

Tier-one companies such as Continental or Bosch spend €10 million to €20 million every year on engineers who labor, not on software development itself, but on keeping the many different software development tools they own interoperable with each other.

Software tools integration has con-

“Expectations Rise for the Automotive Speech Interface”

Big Push from Siri

Talk to carmakers, speech hardware or software developers these days about the state of the art of automotive speech technology, and they’ll tell you that the technology is now poised for significant improvements. Ask them why and they all point to Siri, the heavily advertised conversational speech-activated personal assistant launched in October 2011 as a standard feature on the Apple iPhone 4S. Siri (for Speech Interpretation and Recognition Interface) has raised the speech-interface bar for carmakers.

K. Wayne Powell is general manager of multimedia and telematics engineering at Toyota Technical Center in Ann Arbor, Michigan. He just concluded an independent third-party assessment of Toyota’s voice recognition technology, which shows that Toyota is one of the automotive leaders, but it needs to move quickly to keep up with changing consumer demands. “We’ve got one-shot destination entry by voice, which people really like,” he said. “Our voice recognition systems in the car are not nearly as flexible as they need to be. We need to move [development] even faster.”

With Siri, users can send text or email messages, find answers from the Web, set reminders, check the weather, update their Facebook status or get directions.

Unlike traditional voice recognition systems that require you to remember key words and speak specific commands, Siri mostly understands natural speech, and asks questions if it needs more information to complete a task.

Most people who use Siri like it. According to market research by Parks Associates, more than 71% of iPhone 4S users are either satisfied or very satisfied with the service. Siri is proving once again that the key to Apple’s success is the human-machine interface. Apple’s worldwide sales of mobile devices climbed to 33 million units in the first quarter of 2012, nearly twice what it was in the first quarter of 2011. Carmakers will try to emulate Apple by focusing innovation on the driver interface.

Victor Melfi is the chief strategy officer and senior vice president of marketing at VoiceBox Technologies, developer of Conversational Voice Search software. “People are purchasing cars as a technology center and content-consumption environment. A $17,000 car will get you to the store as easily as a $112,000 car. Carmakers are just now getting their heads around this change in consumer attitudes about what really matters when buying a car. They will start investing. We saw that with Ford Sync—it was a great sales tool, a marketing tool and it increased sales significantly,” he said.

While critical, Siri isn’t the only factor driving advances in automotive speech applications. Because speech is significantly less distracting than visual or manual tasks that take eyes off the road, the distracted driving guidelines proposed by NHTSA (the U.S. National Highway Traffic Safety Administration) lean heavily on speech for secondary tasks while driving.

Texting

The desire to text while driving is also pushing voice recognition technology. Dictating text messages by voice will certainly be less dangerous than thumbing text messages into a smartphone.

“There is huge interest in being able to do SMS texting from the vehicle without distracting the driver,” said Brian Radloff, director of automotive solutions at Nuance Communications, unquestionably.

Turn to Tools, page 2

Turn to Speech, page 3
Tools…

When I first spoke with Mr. Mueller, in 2008, he was optimistic that the auto industry would begin to cooperate on Eclipse open-source tool framework projects. “But the economic crisis hit and things went to pieces for a year and a half,” said Mr. Mueller last month. “Nothing happened. But beginning in 2011, some companies got really interested because they believe it will be very costly if they don’t get this problem fixed.”

A year ago Bosch, Continental, BMW and the Eclipse strategic member, itemis (Lunen, Germany) founded the Open Source Initiative for Automotive Software Development Tools, an Eclipse automotive industry working group known as Auto IWG.

The Auto IWG meeting last month in Toulouse, France, was sparsely attended. The founders were there, along with the functional safety expert Validas. I asked Auto IWG spokesman Ignacio Garro, head of engineering applications systems and software at Continental’s Automotive IT Competence Center, why participation in the Auto IWG is so modest, given the enormity of the interoperability problem.

He said the Auto IWG has not actively tried to recruit new members. Rather, they have wanted to stay small and get some work done first. By the end of June 2012, the group expects to be able to release Work Package One, the Eclipse Automotive Tool Platform (WP1). The platform will include a number of Eclipse software components that are typically used in the auto industry. Some automotive software-development tool makers already base their tools on Eclipse, but they don’t always use the same version, which confounds tool interoperability. “The purpose is to try to get everyone to agree to use the same versions of Eclipse,” said Mr. Garro. Once the WP1 results are available, Mr. Garro expects that some of the carmakers who have expressed interest in the working group will decide to participate in time for the next meeting, set for October 22nd in Ludwigsburg, Germany.

OSLC

Not only is ISO 26262 stimulating interest in software tools integration around Eclipse, but according to Mr. Garro, it is also pushing the adoption of standard procedures to implement the interconnection of tools, such as those defined by the Open Services for Lifecycle Collaboration (OSLC). According to their website, OSLC is a community of software developers and organizations working to standardize the way that software lifecycle tools can share data (for example, requirements, defects, test cases, plans or code) with one another. OSLC publishes free specifications that allow any tool to easily use the data from any other tool.

According to Eclipse’s Mr. Mueller, OSLC’s promising new specification is finding automotive and aerospace industry support. And according to another Eclipse official, Mike Milinkovich, Eclipse projects are already embracing OSLC: “The Eclipse Lyo project contains the reference implementation of OSLC along with an SDK and development test suites.” GM is the only member of OSLC from the automotive industry.

Some automotive tool vendors have informally told Mr. Garro they are very interested in OSLC, but “reserve the right to implement it in the future, or not.”

Roundup FY 2012: Pioneer, Hitachi

Pioneer Car Electronics

FY 2012 Sales: ¥270,785 million ($3.4 billion)
Change from FY 2011: up 6.6%
FY 2012 Operating Margin: 3.8%; operating margin the prior year was 3.5%, following two years of operating losses.
Outlook for FY 2013: Pioneer is forecasting Car Electronics sales of ¥334 billion ($4.2 billion), an increase of 23.4%.

Pioneer calculates that the production stoppages due to the 2011 Japan earthquake and flooding in Thailand later in the year were responsible for a loss of ¥26.5 billion in Car Electronics sales and ¥10.5 billion in operating income. These losses, and the effects of a strong yen, were more than offset by increased sales of car navigation systems, both OEM and aftermarket, mostly in Japan. Sales of car audio products, however, declined. OEM sales accounted for 43% of the Car Electronics segment’s sales, the same percentage as the prior year.

Pioneer’s strategy to meet its aggressive sales growth goal involves strengthening alliances with key OEM customers such as Honda, which owns 4.6% of Pioneer, and increasing sales of navigation systems tailored for regional markets such as China, where Pioneer has a strategic alliance with SAIC. OEM sales are projected to account for 50% of FY 2013 sales.

On the aftermarket side, Pioneer is optimistic about sales of its new navigation system launched last month in Japan, with a head up display that projects augmented reality information on the windshield.

Hitachi Automotive Systems

FY 2012 Sales: ¥811,583 million yen ($10.2 billion)
Change from FY 2011: up 10%
FY 2012 Operating Margin: 4.6%, compared with 3.2% the prior year.
Outlook for FY 2013: Revenue will decline slightly, by 1%, to ¥800 billion. Operating income is forecast to remain at ¥37 billion.

Hitachi attributes its growth to the recovery of vehicle demand globally.
the global leader in ASR (automatic speech recognition). “We’ve got the Dragon Dictation engine that’s been deployed on mobile phones since 2009. We continue to increase its accuracy. It still makes errors occasionally, so you have to build an interface that allows the user to review what was said.” Mr. Radloff believes the ability to send texts by voice will appear in vehicles later this year.

Last month, Nuance announced a new, automotive-grade natural language voice platform based on Dragon Dictation called Dragon Drive. The first application on the new platform will let drivers speak, listen to and respond to texts and emails.

Apple

The car presents obstacles that are difficult for even Siri to overcome. Siri has a much more difficult time understanding what’s been said if road noise is a factor. Text messages are often garbled. Jim Buczkowski, director of electrical and electronic systems research and advanced engineering at Ford, noted, “Texting from the vehicle presents a unique problem. If the text is wrong, how do I edit it?”

Another Siri negative is that driving directions currently are displayed on the iPhone, rather than spoken. “Many of Siri’s responses are not oral but visual,” Mr. Buczkowski said. “To put ‘Siri-like’ features in the car we have to be sure you can always keep your eyes on the road.”

Apple made news this month when it indicated that it has been working with Toyota, Honda, Chrysler, BMW, Audi, Mercedes-Benz, Jaguar and Land Rover to integrate iOS 6-based iPhone devices into future vehicles. Apple’s new software includes turn-by-turn navigation and a new Siri feature called Eyes Free that enables interaction with the iPhone using nothing more than your voice. When the voice command button on the steering wheel is pressed the iPhone screen won’t light up, to minimize distraction.

The Accuracy Problem

The noisy car environment continues to confound the speech recognizer, but a number of improvements in both hardware and software are anticipated that will make car noise less of a problem. For example, additional microphones will be used along with software that will focus a listening beam on the speaker’s face. Nuance Communications has some software that will serve this purpose.

Microphone placement is another difficulty unique to automotive applications. It’s hard to get the microphone close enough to the speaker’s mouth to overcome the ambient noise. The microphone could be moved to the headliner or even to the seatbelt’s shoulder strap to get it closer, said Ford’s Jim Buczkowski, who alluded to some proposals he has seen for “radically different ways to try to eliminate the noise.”

“Voice recognition is very CPU intensive. The more CPU we can throw at the problem, the more sophisticated language modeling techniques we can use,” said Nuance’s Brian Radloff. That computer and memory capability is available in the cloud and eventually, as the price of hardware comes down, more processing power will be available onboard the vehicle.

Beyond Speech Recognition—Conversational and Context Aware

Just as two people talking in a noisy environment ask for and receive confirmation that the listener heard what the speaker said, good speech dialog software can compensate for poor recognition.

“Our customers are starting to understand that focusing on raw recognition might not be the best objective,” said VoiceBox’s Mr. Melfi. “What they want is a speech interface that satisfies people’s needs and lets them comfortabily complete tasks.”

Audi’s connected vehicle strategist, Ponn Malhotra, believes the vehicle’s speech interface will become more conversational. “Today the Audi Connect system provides Google Voice Local Search, which allows you to make a statement and let the system interpret what you intended in a context-relevant search in your area for a point of interest. From there [in the coming years] you will see less and less required from the driver. He won’t have to remember a lot of specific commands.” (To perform a Google search, Audi sends a recording of the speaker’s voice to the cloud, where Google interprets what the driver said.)

DFKI (the German Research Center of Artificial Intelligence) has been doing applied research in speech dialog technology since the 1990s. DFKI is working with Nuance Communications to create a Siri-like experience for cars.

Senior researcher Christian Mueller heads up DFKI’s ten-person automotive group. “The ASR technology we have today has improved considerably. It is really quite useful now, but on the dialog managing side, the auto industry is far behind. The dialog system is the crucial part. It should intuitively guide the user through the speech dialog, enabling a tight interaction, not only with the car’s functions but also with messaging, and access to services and the Internet. That’s where we’re heading.”

According to Mr. Melfi, VoiceBox and Apple own all of the patents around the use of context to manage the natural language user experience, what he refers to as the personal assistant model. “We have 21 patents with 11 more pending,” he said.

“We take the output of the ASR and feed it into our contextual voice search algorithm to better understand the query and provide a more conversational experience across multiple domains. Right now Siri doesn’t have that advanced context. You have to ask Siri one question, then another, then another.

“What VoiceBox does is stack all the contexts of the conversation and allow the machine to listen to and respond to the whole conversation. Out of the blue you could say something like, ‘Play something by Traffic,’ and the music starts playing. Then you can say something like, ‘What’s the traffic ahead like?’ and it gives you the traffic report. Then, ‘Lower the volume,’ and the audio volume goes down. That is an example of two ambiguous contexts being handled by good context management.”

VoiceBox speech software is used by Toyota, Chrysler, Renault, Fiat and Mazda, but none of those automotive speech applications could thus far be called Siri-like. Those models were developed a few years ago when carmakers weren’t concerned with offering a conversational voice interface.

“Siri has been an incredible lightning rod to the industry,” said Mr. Melfi.

“Suddenly all the people with whom we continued on page 8
### The Company Profile... Robert Bosch GmbH

#### Background

Robert Bosch set up his Workshop for Precision Mechanics and Electrical Engineering in Stuttgart 126 years ago. Today, the 51-billion-euro global supplier of automotive and industrial technology, consumer goods and building technology remains privately held, with the Bosch family maintaining 7% of the equity and 7% of voting rights. In 1964, the family transferred the majority of its shares to the nonprofit Robert Bosch Foundation, which sponsors humanitarian, research and social science projects and programs.

#### Bosch Group Sales and EBIT Margins

<table>
<thead>
<tr>
<th>Year</th>
<th>EBIT Margin</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>7.1%</td>
</tr>
<tr>
<td>2007</td>
<td>8.2%</td>
</tr>
<tr>
<td>2008</td>
<td>2.1%</td>
</tr>
</tbody>
</table>

Bosch expects sales will grow between 3% and 5% in 2012.

#### Automotive Technology Sales by Division

<table>
<thead>
<tr>
<th>Sector</th>
<th>2011 Total: €30.4 billion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automotive Systems</td>
<td>38%</td>
</tr>
<tr>
<td>Diesel Systems</td>
<td>14%</td>
</tr>
<tr>
<td>Automotive Electronics</td>
<td>12%</td>
</tr>
<tr>
<td>Chassis Systems Control</td>
<td>10%</td>
</tr>
<tr>
<td>Electrical Drives</td>
<td>9%</td>
</tr>
<tr>
<td>Steering Systems*</td>
<td>6%</td>
</tr>
<tr>
<td>Starter Motors and Generators</td>
<td>6%</td>
</tr>
<tr>
<td>Car Multimedia</td>
<td>3%</td>
</tr>
<tr>
<td>Aftermarket</td>
<td>2%</td>
</tr>
</tbody>
</table>

ZF Lenksystems GmbH (50% Bosch owned) 2011 sales were €3.6 billion.

Nederland B.V. holds a 5.8% voting share. Bosch's size matters, but several other factors contribute to the company's strong standing.

Because Bosch is not publicly traded, it can take the long view in its strategic planning, careful always to liberally fund investments in technology. In 2011 alone, Bosch's Automotive Technology sector invested 10.8% of sales in R&D, a total of €3.3 billion. Bosch is able to consistently invest in its future because it has been consistently profitable. Bosch has been in the black every year since 1945, with the exception of 2009, when the global auto industry was in recession. Even that year, while it showed an operating loss of 3.1% of sales, Bosch still invested €3.6 billion in R&D.

Bosch has a strong global presence close to the world's carmakers. It is already well positioned in Asia, especially in China and India. The company expects its per-vehicle sales in Asia to rise to €210...
in 2012, from €170 in 2008. Its global sales per vehicle will be €400 in 2012.

Of all the carmakers Bosch serves around the world, none are more strategically important than the German premium carmakers who rely on Bosch to help them pioneer new technology—technology that eventually trickles down to the non-premium vehicle segments.

In automotive electronics Bosch is vertically integrated. It produces many of its own sensors and semiconductors, especially power semiconductors.

The world’s leading innovator of diesel and gasoline engine technology, Bosch has already positioned itself for the future as hybrid and electric vehicle penetration slowly rises to significance. Bosch is investing €400 million per year into the development and production of components needed for the electrification of the powertrain including batteries, traction motors, inverters and converters.

Diezel and Gasoline Systems

Bosch will continue to profit for years to come as carmakers—pressured by governments worldwide to significantly improve fuel economy and lower CO2 emissions—increasingly look to buy what Bosch is offering. Of the 103 million vehicles that Bosch anticipates will be produced in 2020, all but three million (electric vehicles) will employ a combustion engine.

Despite the many engine advances available to today’s vehicles, technologies such as turbocharging, direct injection, downsizing, variable valve timing, start-stop and improved thermo-management, most vehicles don’t yet take advantage of all of those fuel-saving features. If they did, “Those advances would yield a 30% improvement in fuel consumption compared with the standard port fuel injection engines,” said Dr. Bohr.

As carmakers optimize their combustion engines, Bosch benefits. Sales of Bosch gasoline direct injection systems are expected to more than double, from four million units in 2011 to 8.6 million in 2014. Sales of Bosch starters adapted for start-stop will also more than double, from 2.7 million units in 2011 to 5.7 million units in 2014. According to Bosch, future start-stop systems will extend the phases in which the engine is switched off, at first to when the vehicle is coasting at less than 12 mph, and eventually to phases when a vehicle equipped with an automatic transmission is coasting at speeds up to 75 mph. Bosch’s common rail diesel system sales will grow from 7.2 million units in 2011, to 9.6 million units in 2014.

Bosch has even entered the turbocharger business, very much a growth market. Founded in 2010, the Bosch Mahle Turbo Systems joint venture began production earlier this year. The Bosch Mahle turbocharger, which delivers pressurized air into the engine to improve combustion, is a passive device, powered by engine exhaust, not electrically. “For many years we considered making an electric turbocharger or putting electronics on it, but in the end the cost benefit of such systems doesn’t pay off,” said Dr. Bohr.

“There is nothing that beats a well-made turbocharger that is exhaust driven.”

According to Dr. Bohr, while the efficiency of a standard port-injected gasoline engine can be improved by 30%, as discussed above, diesel engine efficiencies can also be improved by about that percentage. That will come from downsizing, from start-stop systems, and from friction reduction. “We will see further increases in the injection pressure, going well above 2,000 bars. Injectors will turn on and off faster and will more accurately meter the fuel. We will also use denoxation, not just to get the NOx down, but also to improve the efficiency of the diesel engine. We might allow somewhat higher raw engine-out emissions, which leads to a more efficient combustion process, and then use urea doses or NOx storage catalysts to get the NOx down again,” he said.

Diesel Systems is by far the largest division in the Automotive Technology segment. Bosch’s diesel legacy goes back 76 years to 1936, when the company’s diesel injection technology powered the world’s first diesel passenger car.

Car Multimedia

In the 1990s, Bosch was one of the world’s leading suppliers of high-end infotainment systems, but in 2001 software glitches in Blaupunkt navigation equipment delayed a Mercedes vehicle launch and led to a loss of some major contracts with Mercedes. In 2009 Bosch spun off the Blaupunkt aftermarket radio, speakers and antenna business, as well as continued on following page
the brand name, and moved its OEM navigation and infotainment business to the newly founded Car Multimedia division.

Today Bosch cites the Car Multimedia division “turnaround” as an example of the company’s active portfolio management, which “has struck out in a new, lastingly viable direction,” according to comments made by Franz Fehrenbach, chairman of Bosch’s board of management, in April 2012. “[The division] achieved breakeven in 2010. Since then we have recorded double-digit growth, and current order intake suggests this will continue in the years ahead.”

In the past, Bosch pursued the high end of the infotainment market starting with models like the Mercedes S-Class and working its way down the market. “A decade back we did get out of synch with the high end of that market for a couple of years,” admitted Dr. Bohr. “We have re-entered in the low- to mid-priced segment of the infotainment market, which isn’t a bad position to be in, because this is where the growth is. Nissan is marketing [our] navigation system for between $400 and $500, which is where the market should be to compete with PND makers like Garmin and TomTom. This will bring money back to the OEMs and back to Bosch.”

Since 2010, affordable navigation from Bosch has been available on seven Nissan car models and since 2011, on four GM models as well: the Chevy Cruze and Equinox, GMC Terrain, and Buick Regal.

Bosch’s Car Multimedia division strategy embraces not only infotainment system products but also connectivity, the instrument console and head-up displays, where according to Dr. Bohr, Bosch is gaining market share. The strategy also covers the vehicle’s human machine interface. “HMI is important not only to infotainment, but also safety, especially as we move from driver assistance systems to semi-autonomous driving.” Bosch’s newest infotainment system platform is based on the Linux open source operating system. Car Multimedia also provides its customers and services, technical devices of all kinds

Distinctions Claimed by Bosch

- World’s largest auto parts maker
- The world’s number-one supplier of diesel fuel-injection systems, with 75 million common rail injection systems produced through 2011
- First to market with diesel injection
- First to market with gasoline injection
- First to market with volume-produced ABS
- Inventor of ESP (electronic stability program) which had 44% worldwide penetration of new light vehicles in 2011, with 60% penetration expected for 2016
- 250 million engine control units manufactured at the Salzgitter plant
- Produced more than 111 million airbag control units
- The global market leader in MEMS sensors: 2 billion units produced since 1995
- World’s first production diesel hybrid passenger car uses Bosch hybrid technology

Robert Bosch GmbH Shareholders

- Robert Bosch Foundation GmbH: 92% of equity, no voting rights
- Bosch family: 7% share of equity, 7% of voting rights
- Robert Bosch Industrietreuhand* KG: 93% of voting rights
- Robert Bosch GmbH: 1% share of equity, no voting rights
*Industrial trust

Bosch Group Equity by Year

2006 to 2011 CAGR: 3.7%

<table>
<thead>
<tr>
<th>Year</th>
<th>€ millions</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>22,482</td>
</tr>
<tr>
<td>2007</td>
<td>24,825</td>
</tr>
<tr>
<td>2008</td>
<td>23,009</td>
</tr>
<tr>
<td>2009</td>
<td>23,069</td>
</tr>
<tr>
<td>2010</td>
<td>26,243</td>
</tr>
<tr>
<td>2011</td>
<td>26,917</td>
</tr>
</tbody>
</table>

Internet of Things and Services

During our interview with Dr. Bohr, he suggested that we also talk to someone from Bosch about the company’s newest strategic direction—toward the Internet of things and services (IoTS), also known as Web 3.0, for the third generation of the Web. In its 2011 Annual Report, Bosch describes IoTS as a megatrend that will lead increasingly to the exchange of information among things, where machines, equipment and buildings communicate with each other. Top management at Bosch is committed to making the company a significant player in IoT in all of its businesses: automotive, industrial, consumer goods and building technology. An early step in that direction was taken in 2011 with the acquisition of Inubit AG, based in Berlin. Together with Bosch Software Innovations (the result of the 2008 acquisition of Innovations Software Technology GmbH in Immenstaad, Germany), there are now 450 software specialists available to work on Web-based solutions, according to the company. By 2015, Bosch Software Innovations employment will rise to 1,000.

Speaking at Bosch’s annual press conference in April, Volkmar Denner, who will succeed Franz Fehrenbach as chairman on July 1, 2012, said, “Up to now software has generally been embedded in our hardware. On the Internet of things and services, technical devices of all kinds..."
Dr. Strugala believes that all of the computing on behalf of vehicle control systems, especially safety and engine-related functions, will continue to be embedded aboard the vehicle.

◆ Exemplifying the sort of IoTS businesses Bosch has in mind, in the summer of 2011 the company launched a pilot project in Singapore using Bosch Software Innovations' eMobility Solution software platform. Electric vehicle drivers can locate available charging spots online, reserve them and have the cost of charging added to their electric bill. Three months into the project about a dozen charging stations were operational on the network.

◆ Car-to-x communications is very much a part of Bosch's IoTS thinking. Dr. Strugala believes that LTE (4G) and not DSRC (dedicated short range communications, 802.11p) will provide the communications link. “Even with governments enforcing introduction of the technology on new vehicles, it would take at least until 2019 before enough vehicles (5% to 10% of the vehicles on the road) would be equipped for safety applications to reach critical mass,” said Dr. Strugala. “Better to use existing mobile networks.”

Dr. Bohr is also enthusiastic about the potential of LTE-based car-to-x communications, and he sees an evolutionary implementation of safety-related features beginning within the next three to five years. “If you look at premium cars, most of them have communication capability on them today. The OEMs are already collecting quite a bit of data, maybe sometimes more than the user might know. Everything you need on the car to communicate is there. The entry point we see is probably with safety information,” he said. Possible early communications might include hazardous road condition warnings or an accident stopping traffic ahead or traffic sign identification.

“Safety applications that would include active intervention such as automatic braking or steering to avoid a collision will require DSRC-type communication, faster and more dependable than cellular,” Dr. Bohr said. He believes it will take at least until 2020 before a carmaker puts that type of system on the road. ◆
Intechno Consulting (Basel, Switzerland) recently released Sensor Markets 2016, an analysis and forecast covering 48 types of sensors in 15 major market sectors, including vehicles. Norbert Schröder, principal of Intechno Consulting, shared the following market forecasts for the vehicle sensors. Dr. Schröder cautioned, however, that predicting the market for sensors required in driver assistance systems (radar distance sensors and cameras) was complicated for several reasons including: uncertainty around the price of long-range, medium-range and short-range radar sensors, the timing of when 79 GHz radar sensors will hit the market and possible legislation that would require safety systems such as automatic emergency braking and/or collision warning. He addressed those uncertainties by providing both conservative and optimistic scenarios for those sensors. Our CAGR calculation below takes both forecasts into account.

For more information or to order the report, visit www.intechnoconsulting.com or call 41-61-281 1830.

**New Report from Intechno Consulting on Global Sensors Market**

**World Vehicle Sensor Market Growth by Sensor Type**

<table>
<thead>
<tr>
<th>Sensor Type</th>
<th>2011 Sales (€ Millions)</th>
<th>2011-2016 CAGR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cameras (visible, IR)</td>
<td>1,200.8</td>
<td>23.9%-32.7%*</td>
</tr>
<tr>
<td>Distance sensors</td>
<td>3,712.1</td>
<td>13.5%-27.7%*</td>
</tr>
<tr>
<td>Electric voltage sensors</td>
<td>79.3</td>
<td>33.8%</td>
</tr>
<tr>
<td>Electric current sensors</td>
<td>282.9</td>
<td>22.6%</td>
</tr>
<tr>
<td>Chemical sensors: gases</td>
<td>1,854.8</td>
<td>11.4%</td>
</tr>
<tr>
<td>Quality sensors (e.g. engine oil, fuel)</td>
<td>183.4</td>
<td>11.0%</td>
</tr>
<tr>
<td>Torque and torsion sensors</td>
<td>248.9</td>
<td>9.1%</td>
</tr>
<tr>
<td>Pressure sensors</td>
<td>1,695.4</td>
<td>8.2%</td>
</tr>
<tr>
<td>Temperature sensors</td>
<td>1,877.1</td>
<td>6.9%</td>
</tr>
<tr>
<td>Binary position sensors</td>
<td>476.1</td>
<td>6.6%</td>
</tr>
<tr>
<td>Position sensors</td>
<td>1,645.6</td>
<td>5.6%</td>
</tr>
<tr>
<td>Flow sensors</td>
<td>658.1</td>
<td>5.2%</td>
</tr>
<tr>
<td>Acoustic sensors</td>
<td>446.1</td>
<td>4.4%</td>
</tr>
<tr>
<td>Speed/RPM sensors</td>
<td>995.3</td>
<td>3.8%</td>
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<tr>
<td>Liquid level sensors</td>
<td>386.5</td>
<td>3.7%</td>
</tr>
<tr>
<td>Inertial, navigation sensors</td>
<td>386.2</td>
<td>1.0%</td>
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<tr>
<td>Acceleration sensors</td>
<td>409.9</td>
<td>-1.3%</td>
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<td>Other sensors</td>
<td>719.5</td>
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<tr>
<td><strong>Total Sensors</strong></td>
<td><strong>17,259.40</strong></td>
<td><strong>10.4%-15.4%</strong></td>
</tr>
</tbody>
</table>

*Range is based on Intechno’s conservative and optimistic forecasts. Data: Intechno Consulting

**Automotive Sensor Market Growth by Application**

<table>
<thead>
<tr>
<th>Application</th>
<th>2011 Sales (€ Billions)</th>
<th>2011-2016 CAGR</th>
</tr>
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<tbody>
<tr>
<td>Driver Assistance Systems</td>
<td>4.5</td>
<td>17.1%-30.5%*</td>
</tr>
<tr>
<td>Safety Systems</td>
<td>2.5</td>
<td>6.3%</td>
</tr>
<tr>
<td>Convenience Electronics</td>
<td>2.3</td>
<td>7.5%</td>
</tr>
<tr>
<td>Environmental</td>
<td>3.3</td>
<td>9.5%</td>
</tr>
<tr>
<td>Engines, Transmissions</td>
<td>3.7</td>
<td>8.3%</td>
</tr>
<tr>
<td>Driver Information</td>
<td>0.8</td>
<td>2.4%</td>
</tr>
<tr>
<td><strong>Safety Systems</strong></td>
<td><strong>5.0</strong></td>
<td><strong>15.4%</strong></td>
</tr>
<tr>
<td><strong>Convenience</strong></td>
<td><strong>4.2</strong></td>
<td><strong>12.8%</strong></td>
</tr>
<tr>
<td><strong>Environmental</strong></td>
<td><strong>6.2</strong></td>
<td><strong>12.8%</strong></td>
</tr>
<tr>
<td><strong>Total Sensors</strong></td>
<td><strong>15.4</strong></td>
<td><strong>12.8%</strong></td>
</tr>
</tbody>
</table>

*Range is based on Intechno’s conservative and optimistic forecasts. Data: Intechno Consulting

**Speech...**

have current implementations are saying, “OK, now how quickly can we get that kind of user experience?”

To get to that next level Mr. Melfi believes what is needed, in addition to a green light from top management, is a connected infotainment platform that can seamlessly compute both aboard the vehicle and in the cloud.

**Hybrid Computing Platform**

According to Nuance’s Brian Radloff, the challenge for carmakers in providing a Siri-like experience is how to guarantee that their customers will have a high-quality, high-bandwidth data connection from the vehicle. Secondly, what kind of service are they going to provide for the consumer when he loses the connection? There are still areas of the country where 3G service is not available.

In March 2012 Nuance released for prototyping its Vocon Hybrid Connected software development kit, which relies on a 3G connection to the speech interface in the cloud, but still provides for some speech-operated command and control features when the connection is unavailable. “You can still play your music, operate your climate system or make a phone call,” said Mr. Radloff. “You don’t need 3G for that.”

As Siri has shown, having access to powerful servers in the cloud enhances the user’s experience with speech. “With the cloud you are no longer held hostage to the embedded architecture,” noted Mr. Melfi. “But as the cost of very capable embedded hardware declines, you’ll be able to distribute the speech processing more rationally. The technology is here. Connectivity is here. Embedded costs are going down. You could see all kinds of wizardry happening in the car very soon.”

**Spansion**

While high-end speech interface systems will rely on multicore computers or powerful general-purpose graphics processing units like those from Nvidia, mid-to lower-level systems will benefit from new NOR flash memory technology from Spansion. In a cooperative effort with Nuance, Spansion has optimized its NOR memory chips for automotive speech applications. “We wrap some logic around memory that lets us process information much more quickly, so more complex voice recognition models can be run,” said Alvin Wong, a vice president of marketing and business development for Spansion. “As a result, the speech recognition error rate is reduced, and the CPU can be freed up to do other things.”

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**Speech...**

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