Semiconductor Technology Update: SOI and 3D Chips

I had the occasion to talk recently with Herb Reiter, a well-connected semiconductor industry consultant, who believes the automotive electronics industry should consider the benefits of two semiconductor manufacturing technologies, one old and one new. Relatively mature, silicon on insulator (SOI) technology has been used for a number of years in high-temperature automotive applications by Toyota and Denso, among others. New to the market are 3D chips—stacked die interconnected with through silicon vias.

According to Mr. Reiter, semiconductor suppliers such as IBM and Intel have 3D solutions for computing applications. Qualcomm, STMicroelectronics, Panasonic, Texas Instruments and Samsung have developed prototype 3D ICs for the cell phone industry that are smaller, lighter and consume less power than 2D versions. 3D stacked chips could potentially find high volume cell phone applications in as soon as two years.

Despite the fact that the auto industry is not usually inclined to adopt brand new technology, Mr. Reiter feels that the advantages are great enough that it should begin exploring possible automotive applications for 3D ICs. “In addition to space and power savings, the technology lets you combine a very smart 28-nanometer processor in the same package with a proven semiconductor switch to drive an automotive actuator. ... Another benefit with the stacked chips closer together is RF radiation is less of an issue.”

3D devices are made by stacking chips made from wafers that have had 95% of the silicon material removed. “The circuitry that is doing the work is only in the top 10 micrometers or the top 1% of the wafer,” said Mr. Reiter. “So there is an

Turn to Semiconductors, page 3

LTE Stirs Excitement and Skepticism

Potential Infotainment, Telematics and Safety Applications

When you listen to some of its champions, it’s easy to get excited about the potential impact of Long Term Evolution (LTE) wireless networks on telematics, infotainment and even safety systems. Ideally, LTE will provide cars with super-fast, always-on, Internet Protocol (IP) data communications equal to what many people have at home. Verizon Wireless expects LTE’s average data rates will be five to 12 megabits per second (Mbps) on the downlink and two to five Mbps on the uplink in real-world, loaded-network environments. That’s about five times faster than 3G. The air latency of LTE will be roughly half that of 3G: 27 milliseconds compared with 55 to 60 milliseconds.

And LTE is coming soon. Heavily invested in the new technology, Verizon is on track to launch LTE networks in 25 to 30 U.S. markets, covering 100 million people, by year end. Verizon plans to roll out LTE over its entire U.S. footprint by the end of 2013.

“LTE provides a step function improvement over 3G and that will make a big difference in many applications,” said Derek Kuhn, who was responsible for emerging technologies, including LTE, at Alcatel-Lucent before joining software maker QNX as vice president of marketing. While at Alcatel-Lucent, Mr. Kuhn founded the ng Connect Program to promote LTE adoption worldwide.

“LTE will facilitate cloud-based, machine image processing and recognition for things like driver monitoring,” Mr. Kuhn said. “And because voice goes over an IP connection, you can now use wideband voice and do natural language voice recognition in the cloud. Drivers won’t need to use a command structure any more. They will be able to talk to their vehicle and it will figure out what they want.”

Another LTE champion, Aparna Khurjekar, executive director in Verizon’s business solutions group, expects that LTE will enable new and improved telematics solutions that will invigorate the telematics industry. Verizon’s 2G network is OnStar, the world’s number-one telematics service provider.

“This is an enormous amount of excitement among the OEMs about LTE. Most of the top ten carmakers who are not yet doing telematics have indicated that not only do they want to do safety, security and diagnostics [OnStar’s business case] in the next two to three years, but they want to grow beyond that into convenience and infotainment,” Ms. Khurjekar said.

According to Ms. Khurjekar some of LTE’s most promising automotive applications include mobile hotspots that will let passengers connect their smartphones and tablet computers seamlessly to the Web, and the ability to do video calling from the vehicle.

Turn to LTE, page 2
Despite the enthusiasm, not only from pioneers but from people I’ve spoken with from the automotive industry, some people are pretty skeptical, not only about telematics but also about LTE’s impact on that industry. “Don’t believe the hype,” cautioned industry veteran Russ Shields, who believes that LTE’s impact won’t be felt until 2015 or 2016 at least. He cited a number of reasons for this: First, the LTE modem will initially be quite expensive and coverage in rural areas insufficient early on. Second, Verizon will probably have to charge a premium for any LTE data plan to pay back its multibillion dollar investment. Verizon spent $9 billion for the rights to spectrum in the 700 MHz band on which it is building its LTE network. And lastly, as it was with OnStar’s transition from an analog to a digital wireless network, the transition to LTE will be complicated.

In Mr. Shields’ view, “Open multimedia platforms such as Genivi and Continental’s Android-based AutoLinQ will have a much bigger impact on the industry in the next four or five years than LTE. ... Connected multimedia platforms and downloaded applications will replace telematics,” he said. Mr. Shields is chairman of Ygomi LLC.

According to a product development executive at a tier-one infotainment system supplier, who wasn’t authorized to speak with The Hansen Report, carmakers are showing plenty of interest in LTE, but not much can happen in the near term. “The first LTE modules and LTE base stations to test them on won’t be available until 2012 or so. At this point, we don’t even have pricing information. I expect the first modules will be very expensive and they will probably have some bugs,” he said.

Jeff Orr, principal analyst for mobile devices at ABI Research, which has been following LTE developments since 2006, isn’t buying all the hype either: “Verizon’s LTE network won’t be soon be everywhere [in the U.S.] that 3G is today, and 3G networks are certainly not available everywhere. As you go to different places, whether it’s urban canyons in metropolitan markets or rural markets, the coverage wanes.”

Safety

I got fired up about LTE after talking some months ago with Dan Dodge, CEO of QNX, whose software supports the ng Connect Program’s LTE Connected Car concept vehicle. Mr. Dodge described how he envisions the role of LTE in automotive safety applications:

“I’m driving along, and my chassis control system detects that the wheels slipped. I should be able to upload that to a backend server that aggregates that data, looks at the GPS coordinates of the cars behind me and sends them a notification to slow down, the road is slippery ahead. Or if several vehicles hit their brakes because of fog, the aggregator could inform cars coming up over a hill that there is a slowdown ahead. There are vast resources in the cloud that could distill that information and send it back out without the need for big [government] investments in infrastructure.”

While LTE might well be applicable to driver alert systems such as fog or slippery road warnings, it will not be a replacement for car-to-car or car-to-infrastructure systems based on DSRC (dedicated short range communications) systems.

“With DSRC-based car-to-car communications, each vehicle sends out a signal, and whoever can hear it picks it up,” explained Tom Schaffnit, advanced safety systems engineer at Honda R&D Americas. “There is no network processing of the signals. Even with its lower latency, an LTE network can’t support safety. The example I like to use is, you are entering an intersection and see a car you might get into conflict with. You want to [automatically] call that car to tell him to watch out for you. But what number do you call? The cellular network would have to keep track of where all the cars are and then identify and call any vehicle in a conflict situation. Rather than a cellular network, we need something that works more like a sensor on an autonomous safety system.”

Dave McNamara, an automotive consultant and former top electrical engineer at Ford, agrees that LTE would be problematic in safety applications. “If you’re hitting the event horizon of a traffic jam over the hill and you need to brake, would you trust 4G or 3G for that? I don’t think so.”

According to Mr. McNamara, automotive OEMs would welcome some government involvement in establishing a clear set of requirements and network standards for vehicle-to-vehicle communications. “I’m personally convinced it is going to be very difficult for private industry to take off the shelf technology and apply it to an automotive safety system,” he said.

Loucent Technologies’ Bell Labs, has similar doubts. “Even if LTE was able to satisfy the safety application’s technical requirements, it doesn’t necessarily follow that you would want to do that on a commercial system, it would have to be optimized,” he said. “It also depends on how it is deployed and who is going to take responsibility for the associated risks for such system.”

Off-Board Voice Recognition

Nuance Communications, the global leader in automotive voice recognition and text-to-speech software, is in the midst of transitioning its automotive business from relying exclusively on embedded computers for speech recognition to a hybrid approach. In the new model, some voice processing is still done in the vehi...
### LTE...

Vehicle, for instance audio selections or telephone functions, but the more computer intensive processing, such as interacting with Web-based content and services, is done on backend servers.

While Nuance is already doing some off-board voice processing for OnStar and others using 2G and 3G wireless connectivity, LTE connectivity will reduce latencies as well as provide better overall coverage, according to Arnd Weil, general manager of Nuance Automotive.

"By taking advantage of connected speech services, developers will be able to do things that are too complex and demanding to do on the embedded platform. And they will be able to use a less powerful embedded computer with less memory, since some content can reside off board. It will be a huge step in our ability to provide speech services," he said.

Perhaps the most promising application to benefit from off-board speech processing will be the ability to create text messages while driving without risking your life using SMS (Short Message Service) dictation. Nuance expects automotive revenues to double over the next three to five years largely as a result of hosting connected speech services.

**Rest of World**

According to www.4gamericas.org, operators worldwide have made commitments to roll out 158 LTE networks, with an additional 89 networks potentially on the way. In China two operators, China Mobile and China Telecom, are planning LTE deployments. In Japan, NTT DoCoMo launched a pre-commercial LTE network in June 2010, and KDDI plans to launch in Q4 2012. In South Korea T-Comm Corp. is to launch this year and LG Telecom will launch in 2011. In Germany a Vodafone D2 deployment is underway, while T-Mobile expects to launch in 2011. A number of other LTE rollouts in Western Europe are planned. In the U.S., Metro PCS has had its LTE networks up and running since September 2010.

### Semiconductors...

enormous space savings compared to multichip modules, which have been used by the automotive industry for 20 years. The multichip modules I have seen are about the size of a match box or a little bit smaller. That same functionality in a 3D package could fit in less space than a penny, 100 times smaller.

Among the challenges that will keep 3D devices from automotive applications for at least another four or five years is their currently limited temperature range and thus power limitations. Other challenges 3D chip developers are still addressing include high-productivity design flows (from system level planning to design transfer to manufacturing), perfecting the wafer thinning process and maturing the through silicon via technology that interconnects the die layers.

**SOI**

In contrast with 3D ICs, silicon on insulator is a mature technology from which semiconductor devices can be produced that can withstand operating temperatures ranging as high as 300 degrees C. Utilizing this key SOI advantage will help extend the operating temperature range of 3D solutions.

SOI devices are made by separating the top, active layer of the chip from the bottom 99% with a layer of insulation, which reduces parasitic capacitance and leads to significantly improved performance, lower active power consumption and less leakage.

SOI devices are more expensive than regular CMOS devices, which has limited their adoption by the auto industry, but their high-temperature performance makes them well suited to hybrid- and electric-vehicle applications. They are used by Toyota in the Prius for motor control and in the braking system, as well as in conventional models in throttle, suspension and body control applications.

Among Mr. Reiter’s clients is the Global Semiconductor Association, where he serves as chairman of the 3D/TSV Working Group, driving development of design tools and methodologies for 3D chips using through silicon vias. He also works for the SOI Consortium. Contact Mr. Reiter by email at herb@eda2asic.com.

### Feature Trends: Active Safety Penetration Continues

Safety systems once reserved for high priced luxury cars eventually find their way down to smaller and more affordable cars, sometimes through government mandates, as was the case with electronic stability control, and sometimes as the way a carmaker differentiates its product. Volvo is a good example of this approach.

NHTSA (the U.S. National Highway Traffic Safety Administration) now factors in the presence of ESC, lane departure warning and forward collision warning in its new safety ratings tests.

**Volvo** introduced radar-based adaptive cruise control in 2006 on the S80. It has since refined the technology and introduced Pedestrian Detection with Full Auto Brake this year on the all new S60. The S60’s collision/pedestrian avoidance system is equipped with a dual mode radar sensor in the grille and a camera inside, behind the rear view mirror. If the system identifies a pedestrian in the vehicle’s path and the driver takes no action, full braking power is engaged to bring the vehicle to a complete stop, a first according to Volvo.

**Ford** made adaptive cruise control with collision warning and brake support available on the 2010 Taurus, as well as on the Lincoln MKS and MKT, reporting about a 25% take rate for the option. With the introduction of the new 2011 Edge, Explorer and Lincoln MKX, Ford says it has doubled the availability of the feature.

The brake support function gives the driver a warning, followed by partial braking and, when required, pre-charges the brakes for aggressive braking if the radar

**Continued on page 8**
The Company Profile... Renesas Electronics

Thumbnaill Sketch

NEC Electronics acquired Renesas Technology Corp. on April 1, 2010; the merged company is Renesas Electronics

Headquarters: Nippon Bldg., 2-6-2, Otemachi, Chiyoda-ku, Tokyo 100-0004 Japan

FY 2009 Sales*: ¥1,062.4 billion ($12.615 billion)

R&D: 18% in Q1 2010

Operating Loss*: ¥113.3 billion ($1.3 billion)

Ownership: NEC, 34%; Hitachi, 31%; Mitsubishi Electric, 25%

Products: Microcontrollers, system large scale integrated circuits, analog and power devices

Shareholders' Equity: ¥388.0 billion ($4.61 billion) as of June 30, 2010

Market Capitalization: ¥465.09 billion ($5.52 billion) as of September 17, 2010

FY 2010 Sales**: ¥1,190.0 billion ($14.1 billion)

FY 2010 Operating Income**: ¥7 billion ($83.1 million)

Employees: 48,800 as of June 30, 2010

FY 2009 Automotive Sales: ¥222.3 billion ($2.64 billion)

Key Automotive Products: Microcontrollers, system on chip solutions, and analog and power devices

*NEC Electronics and Renesas Technology combined

**Renesas estimates as of July 29, 2010


For more information on the history of NEC Electronics and Renesas Technology, please refer to their most recent company profiles in The Hansen Report. NEC Electronics was profiled in December 2006; Renesas in July 2004.

Background

The 2010 merger of Renesas Technology with NEC Electronics created the world’s third-largest semiconductor supplier, behind only Intel and Samsung Electronics. On April 1, 2010, NEC Electronics acquired Renesas Technology, a joint venture formed in 2003 when Hitachi and Mitsubishi Electric combined their semiconductor operations. As a result of the acquisition, NEC Corporation, the parent of NEC Electronics, no longer owned 50% of the surviving entity, which meant it could no longer use the NEC name. NEC Electronics therefore changed its name to Renesas Electronics to leverage the brand recognition Renesas has established over the past seven years.

Renesas Technology and NEC Electronics were already the world’s two largest microcontroller suppliers before the merger, and MCUs accounted for 70% of Renesas Electronics’ 2009 automotive sales. The company also produces system on chip (SoC) solutions and a broad range of analog and power devices.

The parent companies reached a definitive agreement on how to integrate their businesses in September 2009. Among their primary goals was to pool development resources and effect economies of scale in many different areas of operations in order to more effectively compete in the global semiconductor market. According to Daniel Mahoney, CEO and president of Renesas Electronics America, eliminating redundancies and reducing overhead will naturally produce improvements in efficiency: “The combination of Renesas Technology and NEC Electronics gives us an increase in overall mass and the ability to invest in strategic market segments. Another important benefit is it makes us a more strategic partner to our customers. Our customers absolutely want to minimize their vendor base, and they want to do business with companies who can provide a broader range of solutions.”

While both NEC Electronics and Renesas Technology were strong in microcontrollers, the merger fills in some gaps in product coverage. “Renesas had a gap at the lower end; the 78K [from NEC Electronics] fits that perfectly. At the other end Renesas Technology had a gap between the 16-bit families and the 32-bit RISC. The V850 [from NEC Electronics] is a perfect fit there,” explained Mr. Mahoney.

Following the merger, Renesas Electronics conducted an analysis of all of its businesses, placing them in one of three...
categories: expanding and growing; ongoing core business; or shrinking business. By concentrating management resources on businesses in the expanding and growing category, such as next generation wireless solutions, SoCs for smart grid applications, security, and electric and hybrid vehicles, the company expects to achieve an average annual growth rate of 7% to 10%.

With its markets in Japan nearly saturated, Renesas will have to grow foreign sales much more quickly in order to meet its growth objectives. The company plans to grow sales to customers outside of Japan from 44% of the total in FY 2009 to 60% in 2012.

Renesas anticipates that the merger’s synergies will yield savings of ¥40 billion ($475 million) from FY 2010 through FY 2012. Those savings will come mainly from integrating development environments and technology platforms, from combining material procurement volumes, and from sharing various facilities.

Renesas Electronics will cut about 4,000 workers from its roster; most of those cuts will come in FY 2010 and will be completed by March 2013. Renesas expects to scale back the amount of development engineering it outsources to two-thirds of its current volume. In addition, Renesas will increase its number of overseas employees from 29% of the total in FY 2010 to 32% by March of 2013.

The new company’s organizational structure includes four product business units: two SoC business units, an MCU business unit, and one that covers analog and power devices.

Renesas maintains 12 wafer fabrication facilities, 10 of which are located in Japan. Including subsidiaries, it also operates 26 assembly and test facilities; 18 of those are in Japan.

Renesas’ major competitors in Japan are Fujitsu and Toshiba.

**Automotive**

Renesas Electronics already has a 42% share of the automotive market for MCUs, well ahead of the number-two supplier, Freescale. Renesas produces semiconductors that are used throughout the vehicle in virtually every domain. All Renesas MCUs have embedded flash memory; MPUs (microprocessor units) have no embedded flash. Its SoCs typically use no embedded flash but have a high level of integration, usually much higher than MCUs or MPUs.

Following the merger, Renesas Electronics will continue to manufacture all of the computing cores that either NEC Electronics or Renesas Technology were making or had committed to offering, and will continue to do so for the next few years at least. These products include the V850, 78K, R8C and SuperH cores. Eventually these technologies will be merged into a future generation product.

“Once development costs have been sunk, it isn’t very expensive to maintain production of a device,” noted Mr. Mahoney. “The real savings from the merger will come from aligning development roadmaps and eliminating redundant product development activity.”

Renesas Electronics expects the automotive semiconductor market to grow over the next five years at 8% per year, on average. Over the same period, the company expects to grow its own automotive sales at 10% per year, roughly.

While some semiconductor suppliers have run hot and cold in their dedication to the auto industry, Renesas says it has stayed committed to the industry for more than 30 years. Why automotive? Yoichi Yano, executive vice president and member of the board of Renesas Electronics, responsible for technology development, was succinct. “The biggest reason is that we are strong in microcontrollers, and automotive is the single biggest microcontroller market segment.” In FY 2009, automotive customers accounted for 21% of the company’s sales.
Renesas Electronics

Having already captured a very large share of the Japanese automotive semiconductor market, Renesas will focus market development efforts on its non-Japanese automotive customers. Renesas is presently the number-one supplier of automotive semiconductors worldwide with a 13% share of the market, but when you exclude its Japanese customers, Renesas ranks number five worldwide, with an 8% share. Ahead of Renesas in the non-Japanese automotive market are Infineon (11%), Freescale (10%), STMicro (9%) and NXP (8%).

Competitive Strengths in Automotive

◆ Experience

Renesas' automotive business, which began solidly in Japan, owes much of its success to the experience it earned serving Japanese carmakers. “We got our start in Japan serving Toyota, Nissan, Honda, actually every Japanese carmaker. After that, we went global,” said Shinichi Iwamoto, senior vice president of Renesas Electronics’ microcontroller business unit.

◆ Global

The automotive business is organized globally. Each of the four regional automotive headquarters—in Japan, China, the U.S. and Europe—has its own sales, marketing, engineering and quality control organizations that meet regularly with their global counterparts to coordinate activities. Regional automotive development work is conducted in Japan, China, India, Vietnam, Malaysia, Singapore, the U.S. and Germany.

“We are in constant discussions to make sure that we are not just taking one region’s product roadmaps and sending them out to other regions, and that our development plans are based on the global community,” noted Jim Trent, vice president in charge of Renesas Electronics America’s automotive business unit.

◆ Integrated Device Manufacturer (IDM)

All of Renesas’ automotive devices come from in-house wafer fabs, which means Renesas has better control of delivery than its fabless competitors. That capability proved beneficial as the auto industry recovered from the recession when semiconductors were in short supply. “Because we have control of our factories, we haven’t had to stand in line to request wafer allocations from outside foundries, like many of our competitors have,” said Mr. Mahoney.

◆ Product Breadth

No automotive semiconductor supplier offers a more complete line of microcontrollers and system LSI devices than Renesas, from entry level to high end and down to very low power. And while it offers some discrete power devices and some analog devices, it plans to broaden those offerings considerably. Renesas’ product roadmaps include plans for a total of more than 300 new products.

◆ Quality

Renesas describes its attention to quality as uncompromising. Indeed, as its failure rates have declined, it has begun to report some devices, some power transistors for example, on a parts per billion (PPB) basis. Even microcontroller failure rates are way down: In 2009 Renesas shipped approximately 85 million V850 32-bit MCUs with a total failure rate of just 1.3 PPM. Fourteen million R8C 16-bit MCUs shipped in 2009 with a total failure rate of just 0.2 PPM. “We strive to continuously improve to zero defects,” said Mr. Trent.

Electrification

For several years Renesas has supplied MCUs for hybrid vehicle applications including running motors and generators, engine controllers and battery management systems, and it is eager to leverage that experience as more carmakers and tier ones become actively engaged in hybrid and electric vehicle development. “We want to be part of the electrification wave,” said Mr. Yano.

“Two areas of experience that will be very helpful to green applications are our motor control micros and low-power versions of our MCUs,” said Mr. Yano. According to Renesas, its low-power flash MCUs consume less than half the power its competitors’ devices require. Next-generation flash MCUs from Renesas made from 40 nanometer processes will require just 0.5 mA/MHz of current.

Renesas is already well established in hybrid and electric vehicle applications with its microcontrollers, and plans to go after that market with its IGBTs, diodes and other power devices as well. The company’s roadmap includes a broader offering of automotive power MOSFETs, IGBTs and power ICs.

<table>
<thead>
<tr>
<th>Major Renesas Partnerships</th>
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<tbody>
<tr>
<td><strong>Date Formed</strong></td>
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<tr>
<td>9/2007</td>
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Green Cars, Safety and Cockpit Electronics

In order to participate in the fastest growing parts of the automotive electronics industry, Renesas planners are focusing on three application areas: vehicle electrification, active and passive safety, and what it calls “comfort,” especially cockpit electronics including infotainment.

The Hansen Report on Automotive Electronics, Portsmouth, NH USA  www.hansenreport.com
Automotive ICs
- Body: V850
- Low-end body: 78K, R8C, K Series
- Powertrain: SuperH, V850
- Chassis: V850, SuperH
- Dashboard: V850, 78K, SuperH
- Airbag: SuperH, V850
- Car audio, connectivity: V850, SuperH
- Car navigation: R-Car
- ADAS: IMAPCAR, SuperH, V850

These automotive MCUs are also supported: M16C, R32C, H8, H8S, H8SX.
As required, automotive ICs include these interfaces: CAN, LIN, FlexRay, SPI, Ethernet and USB.

Standard ICs
- Power ICs
- Operational amplifiers/comparators
- Standard logic

Safety

With more than one million lives lost and more than 20 million people injured in motor vehicle accidents worldwide every year, there is powerful motivation for carmakers and suppliers to create new and better safety systems, and to find ways to make those systems more and more affordable. That work is unceasing.

Headquartered in Japan, Renesas Electronics has been well positioned to work with Toyota, Honda, Nissan and others on active safety innovations. IMAPCAR devices—image processors with advanced parallel processing capabilities for automotive safety systems, first introduced by NEC Electronics in 2006—were crucial to the automotive market (78% worldwide) and 91% of navigation systems: entry-level, mid-price, high-end systems. Among the SoCs presently own 97% of the navigation market (78% worldwide) and 91% of the car audio market (50% worldwide).

This past September, Renesas introduced a new business strategy for its system on chip business that will leverage its strength in multimedia applications. The company is developing an integrated SoC hardware and software platform that will support future product developments in three domains, all of which are becoming increasingly interconnected: R-Mobile, for mobile devices; R-Home, for set-top boxes, Blu-ray disc players and digital TV; and finally, R-Car. In R-Car, Renesas will develop SoCs targeted at three categories of navigation systems: entry-level, mid-range and high-end systems. Among the R-Car developments Renesas will undertake are gesture recognition technology and connectivity features.

Cockpit Electronics and Infotainment

Renesas is particularly enthusiastic about the growth prospects for cockpit systems, including dashboard instrument panel, infotainment and connectivity. “Multimedia is going to explode in the vehicle,” said Mr. Trent. “But this market segment is not without challenges, for example driver distraction is a serious issue, and we intend to be part of that solution. We see a lot of potential for synergy in the cockpit between navigation, connectivity, multimedia and the dashboard.”

Renesas sees great potential for connecting the vehicle to the Internet to take advantage of cloud computing. “This is a huge opportunity for Renesas; it perfectly fits our strengths in communications and connectivity,” said Mr. Mahoney, who believes that cloud computing will not only serve infotainment applications but also safety.

Navigation and infotainment systems, which in their most basic form combine head unit navigation with audio, got their start in Japan where Renesas’ MCUs and SoCs presently own 97% of the navigation market (78% worldwide) and 91% of the car audio market (50% worldwide).

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Major Suppliers

<table>
<thead>
<tr>
<th>Company</th>
<th>1999 Sales (USD)</th>
<th>2009 Sales (USD)</th>
<th>CAGR (%)</th>
</tr>
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<tbody>
<tr>
<td>Hyundai Mobis</td>
<td>1.4 billion</td>
<td>9.2 billion</td>
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<tr>
<td>Continental Automotive</td>
<td>3.4 billion</td>
<td>16.0 billion</td>
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<td>Aisin Seiki (FY ending 3/00 and 3/10)</td>
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<td>24.1 billion</td>
<td>7.5</td>
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<tr>
<td>Denso (FY ending 3/00 and 3/10)</td>
<td>22.3 billion</td>
<td>35.2 billion</td>
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<td>Yazaki Group¹</td>
<td>9.5 billion</td>
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<td>Autoliv</td>
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<td>Bosch Automotive</td>
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<td>Visteon</td>
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<td>Delphi</td>
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Note: All conversions are to 2010 dollars.

¹ FY ending 6/00 and 6/10; approximately 85% of sales is automotive
² Hansen Report estimate

Just three years ago, Siemens VDO was the industry's fastest growing supplier and global vehicle production was barreling toward 73 million units. Of course, the global economic turbulence that began early in 2008 took a toll on all carmakers and the suppliers who serve them. A snapshot of the carmakers' and suppliers' sales growth or decline over the past decade illustrates which companies have profited the most from Detroit's waning influence and how successfully or unsuccessfully the major players have handled the industry upheaval.

Between 1999 and 2009 GM and Ford each lost more than 4% of their market share and their production volumes decreased in the range of 3% per year. Sales of their major suppliers, Delphi and Visteon respectively, shrank at approximately 10% per year during the period.

Toyota, despite its recent recall problems, increased vehicle production at close to 3% per year and its suppliers Aisin Seiki and Denso benefited. Toyota has ownership in both companies.

Hyundai-Kia, the world's most profitable major carmaker, had a 7.7% global market share at the end of 2009 and 10% of the booming Chinese vehicle market. Hyundai Mobis grew along with the carmaker, and through acquisitions.

In Europe, Continental's robust growth is primarily a result of acquisitions. During the last ten years, Continental purchased the automotive electronics businesses spun off by Mercedes (Temic) and Motorola, and it acquired the much larger Siemens VDO, which at the time of the acquisition in 2007 had sales of more than 10 billion euros. Continental was taken over by Schaeffler KG in 2008.

Features...

senses a possible collision. Ford's low-speed “City Safety” system, which automatically brakes the car in traffic at speeds under 20 mph, is now available on the new Ford Focus, along with a Lane Keeping Assist system that nudges the steering wheel if the car starts to drift out of its lane.

Toyota’s version of adaptive cruise control, first introduced on the Lexus in 2004, was brought to the 2010 Prius as an option on the V model.

Blind spot warning systems have gained popularity over the past several years. In J.D. Power and Associates’ 2010 U.S. Automotive Emerging Technologies Study, blind spot detection scored the highest level of consumer interest, 77%, before the price was revealed. But the 2011 Mercedes CL class takes blind spot protection to the next level with Active Blind Spot Assist. If the car moves too close to the adjacent lane after the system issues visible and audible warnings of a vehicle in the blind spot, the wheels on the opposite side of car automatically brake. The resulting yaw movement corrects the car’s path and minimizes the possibility of a collision.

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