GM’s CUE Infotainment System Draws Attention at CES

At General Motors’ booth at the 2012 Consumer Electronics Show in Las Vegas, CUE engineering manager Mike Hichme was busy demonstrating Cadillac’s impressive next-generation infotainment system to a constant stream of visitors. Among them was BMW’s electrical engineering brain trust, led by the carmaker’s top EE, Elmar Frickenstein. Engineers from Audi also visited the booth. Both carmakers take pride in bringing leading edge technology to market.

“We benchmarked BMW and Audi, everyone who was doing something when we began work on the system in 2008,” said Mr. Hichme. The Cadillac User Experience project stayed on track even through GM’s time in bankruptcy.

GM took a clean-slate design approach for the center-stack LCD touch screen and capacitive switch panel, as well as for the natural language speech interface. The CUE interface also provides, on some models, a 12.3-inch reconfigurable instrument cluster display that’s controlled from a five-way switch on the steering wheel.

CUE looks a lot different from other infotainment systems because it was designed, rather than technology or engineering led, according to Mr. Hichme.

“We asked Stuart Norris, lead industrial and graphics design manager for CUE, what he wanted to do with the instrument panel. One example of the innovations he asked for was more storage space, so our engineers relocated the radio boxes usually installed in the center stack to make room for a 1.8-liter storage space,” Mr. Hichme said. The storage area is behind the motorized capacitive-touch control panel and provides a USB connector for mobile devices.

Turn to CUE, page 8

Automotive Ethernet: Interest Great and So Are Obstacles

LVDS and MOST Won’t Soon Go Away

It is easy to get excited about automotive Ethernet. Ethernet is the world’s most ubiquitous computer networking technology, so components, software, development and debug tools, as well as experts, should be plentiful and inexpensive. And with automotive bandwidth requirements inevitably growing beyond the capabilities of CAN, LIN, FlexRay and eventually MOST, Ethernet’s scalable data rates from 10 Mbps up to 100 Gbps further add to its appeal. An open architecture where multiple players can participate in creating solutions, Ethernet is compatible with Internet Protocol (IP) and other network protocols. Ethernet’s most promising feature is probably its flexibility. In the long term it could replace multiple existing networks with one, thereby vastly simplifying vehicle architectures, lowering costs and enabling more integration and reduced complexity.

Ethernet holds so much promise that over the last few years most carmakers worldwide have become very interested in the technology. While standard Ethernet physical layers have been used for vehicle diagnostics for several years, many carmakers are now seriously looking at using Ethernet initially for 360-degree camera systems, followed by a network that would provide active safety systems with access to all of the high bandwidth sensors in the car, including not only cameras but also radar, Lidar and ultrasound.

Infotainment, where carmakers currently employ SMSC’s proprietary MOST network technology to link head units to audio amplifiers, front and rear displays and other peripherals, is another domain where Ethernet would perform well. An Ethernet backbone could eventually link multiple vehicle domains.

BMW Commits to Ethernet

The leading promoter of automotive Ethernet, BMW, has been using Ethernet links for fast data downloads and as a diagnostics interface since 2008. In 2013, the carmaker will launch a four-camera, surround-view system using IP-based Ethernet in the new X5. “This is an investment in the future,” said BMW’s top electrical engineer, Elmar Frickenstein. “If our cameras are IP-based, we can eventually use the same cameras for multiple applications.”

In 2015, BMW will begin transitioning from MOST to Ethernet as its infotainment system network across all car lines.

Turn to Ethernet, page 2
Eventually Ethernet and IP will serve as the backbone for BMW's highly integrated domain architecture, linking powertrain, suspension, comfort and infotainment.

A two-day conference on automotive Ethernet and IP technology sponsored by BMW this past November drew more than 300 participants. Featured at the Munich event were presentations from BMW, General Motors, Toyota, Daimler and Volkswagen, among others.

OPEN Alliance and AVnu

Also this past November, the OPEN (One Pair Ether-Net) Alliance Special Interest Group was founded to develop and promote the automotive adoption of Ethernet-based, single-pair unshielded networks as the standard in automotive applications. One of the biggest obstacles to using Ethernet communications in the vehicle has been electromagnetic interference. To protect the vehicle, expensive shielded cables were required, which would severely limit wide-scale adoption of automotive Ethernet.

Broadcom Corporation, a $7 billion semiconductor supplier that specializes in wired and wireless communications, has developed a technology it calls BroadR-Reach, which overcomes the EMI issues, permitting 100 Mbps Ethernet transmissions over less costly, lighter weight, unshielded twisted pair (UTP) cables. OPEN Alliance promoters include BMW, Broadcom, Continental, Freescale, Harman, Hyundai, Jaguar Land Rover, Lear, Renesas and NXP. Broadcom will begin producing automotive transceivers and switches next year. NXP, which licensed the BroadR-Reach technology from Broadcom, will supply automotive-grade semiconductors starting with first samples available in 2012.

“We established the OPEN Alliance in November with eight members; now we have at least twenty-two,” said Ali Abaye, senior director of product marketing for Broadcom. Broadcom is new to the auto industry.

While the OPEN Alliance is dealing with the physical layer, another consortium, the AVnu Alliance, founded in August 2009, deals with the network protocol. Dedicated to the advancement of professional quality audio/video, and serving the automotive, professional and consumer electronics markets, the forum is promoting the adoption of IEEE 802.1 Audio Video Bridging (AVB). AVB would work over an Ethernet or other network physical layer. In June 2011, three automotive industry players joined the AVnu Alliance: Hyundai Motor, Renesas and Texas Instruments. Broadcom, Harman, Xilinx, Analog Devices and Bosch were already members.

Automotive Ethernet Activity Growing

“All carmakers are looking at Ethernet solutions, some more aggressively than others. But given the [lack of] maturity of automotive Ethernet, I don’t know anybody who has yet completed all their analysis and made a full decision that Ethernet is going to replace everything going forward,” said Nick DiFiore, director of Xilinx’s automotive segment. At the 2012 Consumer Electronics Show, Xilinx

U.S. Average New Vehicle Prices Grow Slowly

Electrical/electronics content as a percentage of the vehicle's cost can’t increase forever. There is a limit, and according to some top OE electrical engineers, that limit was reached a few years ago in non-hybrid and non-electric vehicles. E/E content in electric and hybrid vehicles, however, is higher and as more of these vehicles are built, average content will increase.

The remaining components of E/E market growth are increased light vehicle unit sales, and increases in the average retail price, assuming higher prices translate into larger budgets for electrical and electronics parts.

In the ten years from 2000 through 2010, the average retail price of new vehicles purchased in the United States increased just 2.1% annually, according to data from the U.S. Bureau of Transportation Statistics. Unit sales of new vehicles in the U.S. declined 4% annually in that period.

While the BTS has not yet released figures for 2011, consumer car buying website TrueCar.com reported the average U.S. transaction price in May 2011 was 2.9% higher compared to May 2010. Global vehicle production increased 2.9% per year during the decade.

**U.S. Average New Vehicle Price 2000–2010**

<table>
<thead>
<tr>
<th>Year</th>
<th>Price (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>18,850</td>
</tr>
<tr>
<td>2001</td>
<td>19,205</td>
</tr>
<tr>
<td>2002</td>
<td>19,507</td>
</tr>
<tr>
<td>2003</td>
<td>20,894</td>
</tr>
<tr>
<td>2004</td>
<td>21,850</td>
</tr>
<tr>
<td>2005</td>
<td>22,005</td>
</tr>
<tr>
<td>2006</td>
<td>22,894</td>
</tr>
<tr>
<td>2007</td>
<td>24,082</td>
</tr>
<tr>
<td>2008</td>
<td>24,796</td>
</tr>
<tr>
<td>2009</td>
<td>26,854</td>
</tr>
</tbody>
</table>
| 2010 | 26,950     

Source: U.S. Bureau of Transportation Statistics, revised January 2012

**THE HANSEN REPORT**

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Ethernet... 

Ethernet... demonstrated an FPGA- (field programmable gate array) based Ethernet AVB network featuring multi-camera driver assistance and audio/video streaming simultaneously on a single network.

General Motors has been engaged in a number of engineering and research projects related to using Ethernet for backbone and control and has had ongoing discussions with Ford, Chrysler, Toyota and others as it evaluates different technology options.

“Jaguar Land Rover plans to introduce an infotainment system based on Ethernet by 2015,” said Gerhard Fleischmann, a Lear engineering director. “Hyundai has said they want to introduce Ethernet in several domains. Engineers at Daimler, Toyota and Volkswagen are also seriously considering Ethernet,” he said. Lear began developing automotive Ethernet applications in 2005 and began producing Ethernet gateways in 2008. Working closely with BMW, Lear has participated in the development of Ethernet cameras, as well as networks for audio and infotainment systems.

Porsche also developed a camera system linked by an Ethernet network. The feature is scheduled to launch in 2014.

Hyundai is targeting 2014 or 2015 for the rollout of its multi-camera system but is still undecided about whether or not it will use Ethernet. “We are trying to figure out which network is best—Ethernet, MOST 150 or even IEEE 1394,” said Chris Sirh, electric/electronic system platform team leader at Hyundai. “We aren’t yet certain that unshielded twisted pair cable will meet our electromagnetic interference specs.”

BMW’s Mr. Frickenstein told us that he is 100% sure that the Broadcom solution solves the EMC problem over unshielded twisted pair for his surround-view camera application. But not everyone is convinced, according to Markus Plankensteiner, director of marketing for TTech. “OEMs are questioning whether the Broadcom solution is the right one,” he observed. TTech developed TTEthernet, now an IEEE standard and publicly available, which could serve as an Ethernet backbone.

Hyundai’s Mr. Sirh would definitely like to use fewer network protocols, eventually. “It is ridiculous to be using one CAN network, one Ethernet network, one MOST 25 network and one MOST 150 network. So we are going to merge them together someday. ... Ethernet can be used for the camera interfaces, for the multimedia system, the engine ECU, even the body control unit. But it is not yet stable for the automotive area.”

At this point in its development, automotive Ethernet is suffering from a chicken and egg dilemma, explained Lear’s Mr. Fleischmann. “Semiconductor vendors are reluctant to license the Broadcom IP without the right OEM commitment. On the other hand, we have the OEMs who are reluctant to commit to Ethernet without multiple vendors. They want to avoid having the same solution they have with MOST, where they are dependent on only one semiconductor supplier.” SMSC is the exclusive supplier of MOST semiconductors and software.

Ethernet vs. MOST

Hyundai first used MOST in 2007 on the Genesis, and presently uses it in infotainment systems to connect head units to amplifiers, monitors and other peripheral devices. “If the price of MOST were to come down,” Mr. Sirh said, “we’d ask ourselves, ‘Why should we change to Ethernet?’ We have experience with MOST; it would be much easier to apply those solutions to our next vehicles.”

Other carmakers, including Audi, Volkswagen and Daimler, have indicated they too are reluctant to move away from MOST, where they already have considerable experience, to Ethernet technology, which is new to the automotive industry. “Audi and Daimler have both said their next-generation infotainment systems will be based on MOST 150. Volkswagen has also made a commitment to MOST,” said Henry Muyschondt, senior director of automotive business development at SMSC.

While these carmakers apply MOST to infotainment applications today, they are also looking at MOST for driver assist camera systems, according to Mr. Muyschondt. “MOST doesn’t have the latency problem Ethernet has,” he said. “If you are doing driver assist with cameras, you can’t afford more than a few milliseconds of latency between the time the picture is captured and when it is presented to the driver.”

Ethernet vs. LVDS 

Ethernet won’t soon replace LVDS (low voltage differential signaling) communications in high-bandwidth, point-to-point applications such as high-resolution video streaming. “Among the world’s five largest carmakers, three of them are using our LVDS technology for next generation systems,” said Stephen Kempainen, strategic marketing director, signal and data path solutions, Texas Instruments. Texas Instruments manufactures FPD-Link product manager, Thomas Wirschem.

TI analyzed what a four-camera surround-view system would cost in 2014 and concluded that its FPD-Link solution over coax would cost a little over $60, including the cable and electronic circuitry, compared with nearly $80 for either the Ethernet solution over un-shielded twisted pair, or their FTP-Link over shielded twisted pair. Much of the Ethernet solution’s disadvantage comes from the cost of each camera’s microcontroller, needed for motion JPEG compression and packetization.

“Driver assist architectures are moving toward megapixel images, which means you are transferring more than one gigabit of data,” said TI’s data path design director, Andy McLean. “Ethernet systems using BroadR-Reach are limited to transfers of 100 megabits, plus. As a result you have to use some form of data compression and decompression.”

continued on page 8
The Company Profile...  Garmin

Background
Since its founding in 1989 through the close of fiscal year 2010, Garmin has sold 81 million GPS-enabled devices globally, considerably more than any other supplier. Anticipating the U.S. government's opening of access to its network of global positioning satellites for commercial use, Garmin founders Gary Burrell and Min Kao began designing GPS navigation products in 1990. The U.S. military stopped its practice of degrading the accuracy of GPS signals, the practice known as selective availability (SA), in 2000, which meant commercial vendors like Garmin could begin selling navigation units with an average accuracy of roughly 30 feet (instead of 150–300 feet with SA), sufficient for automotive turn-by-turn route guidance.

Garmin's fiscal year ends on the last Saturday of the year.

The founders took the company public in December 2000. Five years later, sales topped $1 billion with a net margin of 30%. Garmin remained a very, very profitable company with margins far beyond the reach of traditional automotive electronics suppliers. The company has no outstanding long-term debt.

Automotive/Mobile Products
Garmin launched its first plug-and-play portable automotive GPS unit with preloaded maps of the entire United States, the StreetPilot 2620, in March 2004, at a manufacturer's suggested retail price of $1,516.65. Since then, prices have obviously fallen dramatically, while available features have expanded well beyond the basic navigation and points of interest delivered by StreetPilot.

Nüvi
Introduced six years ago, Nüvi is Garmin's current signature product line of portable navigation devices, accounting for 54% of company sales in 2010. At the end of 2010, Garmin offered 52 Nüvi models.

This excerpt from Garmin's 2010 Annual Report describes the Nüvi line:
Garmin Sales by Region

<table>
<thead>
<tr>
<th>Region</th>
<th>FY 2011 Total Sales: $2,759 million</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europe</td>
<td>35.6%</td>
</tr>
<tr>
<td>Asia</td>
<td>9%</td>
</tr>
<tr>
<td>North America</td>
<td>55.4%</td>
</tr>
<tr>
<td>Taiwan</td>
<td>39%</td>
</tr>
</tbody>
</table>

Garmin Full- and Part-Time Employees by Country/Region

<table>
<thead>
<tr>
<th>Country/Region</th>
<th>Total at Year-End FY 2010: 8,897</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>340%</td>
</tr>
<tr>
<td>Taiwan</td>
<td>50%</td>
</tr>
<tr>
<td>Europe</td>
<td>8%</td>
</tr>
<tr>
<td>Canada</td>
<td>1%</td>
</tr>
<tr>
<td>Other</td>
<td>2%</td>
</tr>
</tbody>
</table>

Distinctions Claimed by Garmin

- World’s number-one navigation device supplier with 38% of the global PND market
- Garmin sold nearly 16 million navigation units in 2011 (in all its served markets).
- Garmin’s December 2011 share of N.A. PND market, 64%; TomTom’s, 27%
- Garmin’s market share in Europe, 25% to 30%; TomTom’s, 30%-35%
- Garmin navigation on the Dodge Charger and Chrysler 300 won first and third place, respectively, in J.D. Power and Associates’ 2011 Navigation Usage Satisfaction Study.

Global Installed Base of Navigation Devices by Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Cumulative Total in Units Year-End 2011: 340 million</th>
</tr>
</thead>
<tbody>
<tr>
<td>PNDs</td>
<td>150</td>
</tr>
<tr>
<td>Navigation-enabled mobile phones</td>
<td>130</td>
</tr>
</tbody>
</table>

“The company will also develop new software that has already been developed for consumer applications. Using engineering capability from within Garmin, but outside the Automotive OEM group, the company will also develop new software on behalf of its customers.”

Three other products fill out Garmin’s Automotive/Mobile product line: Zumo (four models for motorcycles), StreetPilot (now a navigation app for iPhones and iPads) and Garmin Mobile for BlackBerry (a subscription-based app that lets BlackBerry devices function as GPS navigators).

“Garmin established its Automotive OEM Group in 2009, as an internal business segment within the Automotive/Mobile segment that produces the Nüvi line of PNDs. In May 2011, Matt Munn left the infotainment market leader, Harman International, where he was senior vice president in charge of global sales and marketing and general manager of global customer business units, to take over Garmin’s Automotive OEM Group. Mr. Munn spent five years in Germany in an executive position while at Harman.

Thus far, Garmin’s automotive OEM sales have been limited to navigation devices, modules and navigation software, but Garmin is moving up the supply chain with the intention of becoming a market leader in the crowded infotainment field. That doesn’t mean they’ll begin producing external audio amplifiers and speakers anytime soon, but they do intend to produce head units including the navigation core, display, tuners, onboard amplifiers, connectivity to embedded modems, portable devices and the cloud, and if necessary, drives. These days the most expensive and challenging component of infotainment is software, especially the human machine interface, and that is something Garmin knows a good deal about given its number-one share of the global portable navigation device market.

The Automotive OEM Group is part of a matrix organization that will leverage software that has already been developed for consumer applications. Using engineering capability from within Garmin, but outside the Automotive OEM group, the company will also develop new software on behalf of its customers.”

“We are committed to this for the long haul,” said Mr. Munn. “We are investing in the OEM space. We are building infrastructure and capabilities. We acquired [the German navigation software and PND maker] Navigon AG. Garmin is in a very stable financial position with a significant amount of cash. We are not just going to sell PNDs and if that doesn’t work, go away. We’re committed to becoming a true infotainment partner.”

Mr. Munn is based at Garmin’s Detroit-area office, which employs roughly a dozen people. The office will grow as Garmin picks up infotainment business.

Garmin will soon open OEM Automotive sales offices in Shanghai, China, and Yokohama, Japan.

continued on following page
A number of carmakers including Cadillac, Ford, Audi and Toyota have brought infotainment systems to market without the sort of system integration support that tier-one infotainment companies usually provide. “Though they have struggled with it lately, Ford has taken this approach [with Sync 2],” said Mr. Munn. “We plan to serve our partners in any way they need us. In some cases we will be software partners; in others we will provide full infotainment solutions.” While Garmin is willing to explore a variety of business models, it is not interested in providing only engineering services.

Mr. Munn was not able to disclose if Garmin has yet won infotainment system business, saying only that “some announcements about awards will be made very soon. ... The OEM segment expects profitable double-digit revenue growth over the next several years.”

Competitive Strengths
◆ Vertical Integration
Garmin is able to profitably compete in the low-price PND market because its costs are low. That and its large production volumes should help the company compete for automotive OEM business.

Garmin develops and produces the hardware that comprises its products. “We do the glass bonding for our touch panels in-house, for example, and we handle all the environmental protection, and the anti-reflective and high-temperature requirements for automotive, marine and avionics applications,” said Mr. Munn. Garmin purchases TFT LCDs. Microcontrollers come from Texas Instruments and STMicroelectronics.

Software is the biggest component of infotainment system development, and Garmin develops its own. Most software is written at its R&D facility in Olathe, Kansas, but Garmin programmers in Taiwan, Germany and Shanghai also make contributions.

Garmin is proud of its ability to come quickly to market with new developments. “Our strong commitment to vertical integration, in design, R&D and production, means that we don’t rely very much on third parties, and that increases our speed to market,” said Mr. Munn.

◆ Consumer, Avionics Market Experience, plus Brand
Also underpinning Garmin’s ability to bring new products to market faster than traditional automotive suppliers is its experience in both consumer electronics and avionics. Garmin plans to leverage that experience as it pursues automotive OEM business. Clint Steiner, global director of sales and business development for the Automotive OEM group, believes, “We can bring what works in the consumer market to our automotive customers.” Attributes that attract customers to Garmin PNDs, such as its well-known brand, ease of use and advanced graphics capabilities, can also be beneficially applied in the OEM market.

Garmin’s $270 million avionics business further distinguishes it from other automotive infotainment systems suppliers. As Mr. Munn said, “I don’t think there is a single automotive OEM supplier who is making the cockpit of the Citation X aircraft.” According to the jet plane’s maker, Cessna, the Citation X is the fastest civilian aircraft in the sky. Garmin’s avionics product line includes GPS-enabled navigation, VHF communications transmitters/receivers, multifunction displays and electronic flight instrumentation systems, among others.

“The breadth of our business and our unit volumes give us a different mindset than the traditional automotive supplier,” said Mr. Munn.

K2 Platform
To demonstrate what it can provide to carmakers, Garmin presented its K2 next-generation infotainment platform at the 2012 Consumer Electronics Show. K2 is scalable and modular. It supports phone connectivity for calls, app integration, calendar reminders and texting. The platform will support predictive features around traffic, destination search and routing. K2 is presently running on a QNX Car application platform, though according to Mr. Munn, “The specific operating system is not that critical to our platform design; K2 will run on multiple operating systems.” The system is targeted for vehicle applications in 2014 and 2015. While Garmin has its own operating system, in the near term Mr. Munn sees QNX and Linux, but not Android or Microsoft, as “viable solutions” for Garmin’s infotainment products.

Major Automotive Customers
◆ Chrysler
Garmin’s first factory-installed embedded navigation customer should be pleased: Garmin navigation systems on the 2011 Dodge Charger and Chrysler 300
The Hansen Report on Automotive Electronics, Portsmouth, NH USA www.hansenreport.com

Series earned first and third place, respectively, in J.D. Power and Associates’ 2011 U.S. Navigation Usage and Satisfaction Study. According to J.D. Power, customers rank ease of use as the most important navigation system attribute, which happens to be the category where the Dodge Charger’s navigation system shined.

“When you turn on your Chrysler vehicle and go to the navigation screen, it looks very familiar,” said Mr. Munn. “Being able to input your destination very easily is an area where Garmin has stood apart from the pack.”

“To win J.D. Power in our first year of being eligible for the award is a big deal to us. We won with a Garmin look and feel,” added Mr. Steiner. Garmin supplies the navigation board and navigation software to Panasonic, who delivers the Uconnect Touch head unit to Chrysler.

The optional Garmin navigation platform has been available since the 2011 model year on Chrysler 300, Dodge Charger and Dodge Journey vehicles. Garmin’s Chrysler offerings have been enhanced for the 2012 model year. Voice recognition now comprehends almost any point of interest and lets users enter a destination address in full with just one utterance. Another 2012 product enhancement is dead reckoning. Gyro sensors installed in the navigation unit help track your location even when GPS signals are unavailable.

Also new in the 2012 model year is traffic information. Garmin Navigation including SiriusXM Travel Link and a one-year free SiriusXM Traffic subscription is a $795 option on some 2012 Chrysler 300 trim lines, which get the basic Uconnect Touch system as a standard feature.

Chrysler will get some more enhancements to the Garmin navigation platform for the 2013 model year, for example photo-realistic views of junctions to make complicated turns easier to negotiate. Millions of Garmin PNDs serving the consumer market already have the junction view feature.

Since the 2011 model year, Garmin has supplied navigation boards and software for Chrysler’s Media Center 430N head unit, available on Chrysler SUVs, Ram trucks, Jeep Grand Cherokee and Wrangler. That system’s tier-one supplier is Mitsubishi Electric. Garmin shipped about 200,000 Chrysler navigation platforms in 2011 as a tier-two supplier.

◆ Panasonic

In addition to its business with Panasonic on behalf of Chrysler, Garmin supplies navigation software to Panasonic for Toyota and Honda vehicles sold in some Southeast Asian markets.

◆ Suzuki

Garmin’s business with Suzuki in North America started with an integrated navigation unit in the 2009 Suzuki SX4. In November 2010, Garmin announced that it would provide an integrated navigation package for the 2011 Suzuki Grand Vitara, as well as SX4 models, which would offer connectivity to online information like Google local search, traffic, weather, fuel prices, movie listings, flight status, local events and white page telephone listings. The two companies continued their collaboration into the 2012 model year with more features and services to be delivered via AT&T Wireless.

◆ Kenwood

Garmin has been supplying port-installed navigation boards and software to Kenwood since 2006. That business was initially aimed at North America, but now includes Kenwood’s European and most global requirements as well. Garmin also provides Kenwood with stand-alone black-box navigation units including the user interface, and Garmin navigation software is in Isuzu’s dealer-installed head unit from Kenwood.

◆ BMW

In a business arrangement underway for nearly five years, Garmin PNDs are integrated post-production into BMWs, Minis and BMW motorcycles.

◆ Rental Car Customers

Avis/Budget; Enterprise Group (Enterprise, National, Alamo); Dollar/Thifty

Garmin continues to supply PNDs to the car rental companies listed above. Traffic options are among the new features offered to rental car companies in response to their RFQs.

Garmin PNDs can be equipped with an integrated NAVTEQ traffic receiver, either an FM RDS (Radio Data System) receiver or an HD radio receiver. RDS traffic updates take five or six minutes to receive; HD updates take less than two minutes.

Embedded vs. PND vs. Smartphone Navigation Markets

It is Garmin’s view that the three automotive navigation markets—embedded, PNDs, and smartphone apps—will coexist. Mr. Munn observed: “When cell phone navigation came along, people said that it would kill PNDs. It hasn’t. When PNDs came along people said they would kill embedded navigation. They haven’t. I believe there is a place for each type. We use them differently. All of them have advantages and disadvantages. Each version seems to complement the other—seeing PNDs makes people want embedded navigation.”

Mr. Munn doesn’t expect to see any big changes in navigation technology; rather, he expects the technology will evolve. “The graphics will get better and voice input and output technology will get better, and that will improve the user experience,” he predicted. ◆
Tier One: GM

Like Audi and Ford, who brought some infotainment system development in house, General Motors developed CUE without the usual integration support from a tier-one supplier.

“GM is the system integrator,” said Mr. Hichme. “We brought together a group of partners. We are coordinating their releases and the testing, but we haven’t [vertically] integrated as low as Ford has gone. There are several modules with different software pieces that we are integrating.”

The CUE center stack has 25 million lines of code; the reconfigurable cluster has 15 million to 20 million lines of code.

Among CUE’s partners are Bosch, for the infotainment head unit and much of the software; Delphi, for the cluster; and Panasonic, formerly Sanyo, for the center control panel. Freescale supplies the i.MX51 ARM microcontrollers that run the cluster. The ARM 11 three-core microcontroller running the center stack comes from Renesas. The speech engine is from Nuance. The infotainment system’s Linux operating system is supplied by MontaVista Software.

The eight-inch capacitive LCD touch screen was developed by a supplier on behalf of GM. “You can think of us as a tier one for the screen,” said Mr. Hichme. “We didn’t want to depend on somebody else to define that for us.”

The CUE infotainment system is built on a Linux operating system, but not on Genivi, the open source infotainment software stack based on Linux. “When we started this project more than three years ago we wanted to do a Genivi-compliant build, but Genivi wasn’t nearly ready,” said Mr. Hichme. “So we decided we’d do a Linux-based platform knowing that at the time Genivi was heading toward Linux; we could easily migrate to Genivi as it matures.” The system uses an HTML 5 framework with many of the native features programmed in C.

CUE makes use of a MOST 50 (megabits per second) copper bus. “We wanted users to be able to browse media and the phone list using the steering wheel controls while looking at the cluster,” said Mr. Hichme. “I don’t have to look over at the center stack. I can do this because of the MOST network, which connects every one of the infotainment components. That was big for us.”

**Noteworthy Features of CUE**

- Unlike MyFord Touch, which has a resistive touch screen, CUE’s touch screen is capacitive, which means less pressure is needed to activate it. Similar to iPads and iPhones, CUE accommodates swipe and pinching gestures to move and resize items such as maps on the screen.
- The touch screen provides haptic feedback. Buttons on the screen pulse to affirm that the command is understood.
- Touch switches on the center face plate respond to multiple inputs, for example, the audio volume control can be swiped, tapped or held to raise or lower the volume.
- To minimize clutter, some icons on the center display disappear when the car is in motion. The display is equipped with four photo diodes, two on each side, which recognize a hand as it approaches, and brings the icons back to life.
- Available on high-end XTS models, the reconfigurable cluster has four different operating modes, from simple to sophisticated, selectable and controllable from the five-way controller on the steering wheel. The base-level cluster, although not reconfigurable, has a similar interface for media, phone and navigation, but on a smaller display.
- A five-way switch on the left side of the steering wheel manages cruise control functions, voice recognition, phone hang-up and heated steering wheel.
- CUE can access up to ten Bluetooth-enabled mobile devices, USB sticks, SD cards and MP3 players. It automatically aggregates music from multiple media devices into a single list.
- With natural voice recognition, users can control media, navigation, phone and weather reports. Text-to-speech handles incoming texts; automated or customized responses can be sent.
- CUE’s software can be updated throughout the life of the vehicle.
- CUE features iPad- and iPhone-like elements such as a mechanical “home” button, which when pressed always brings up the home screen. And its menu functions are icon-based. “We also accommodate the simple user who may not have an iPad or anything like that,” said Mr. Hichme. “They press the home button and are presented with only a few big icons. If they press audio they are in the radio. There is seek and there is band and that’s most of it. They can save some presets, and they are done.”

“CUE is very impressive,” noted Egil Juliussen, principal infotainment analyst at IHS Automotive. “The user interface will feel very familiar to drivers. It could make BMW’s and Audi’s user interfaces obsolete.”

As Ford has proven with Sync, the infotainment system can have a huge impact, good or bad, on car sales. Whether CUE is successful will depend on the full range of Cadillac customers—not only the tech-savvy, who will appreciate how capable it is and how easily it can be customized, but also with the tech-averse—depends enormously on how easy and intuitive it is to operate, which is largely a matter of software programming.

GM is proud of its branded CUE system and is promoting it well in advance of the first offering of the system in late spring 2012, on the new Cadillac XTS luxury sedan. CUE will also be offered on the ATS compact sedan coming out this summer and on the SRX luxury crossover, due later in the summer.

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**Ethernet…**

Mr. Kempainen also emphasized the distinction that BroadR-Reach is not part of the IEEE 802.3 Ethernet family of standards, but proprietary to Broadcom. He also noted that while the Broadcom solution has theoretically overcome the EMC challenges, it has yet to be tested in “the real world of mass vehicle production.”

Xilinx’s Nick DiFiore agrees that, for now at least, LVDS has a role to play.

“There are going to be a lot of cases where just having a simple LVDS link between two points makes a lot of sense in terms of cost and performance. But it doesn’t make a network, and you need a network if you want to share the camera data.”