Electrification Challenge: Cost Effective Motors and Inverters

In 2006 the U.S. Department of Energy (DOE) established technology development targets for electric traction motors, gearboxes and inverters that would enable the commercialization of hybrid electric vehicles. The criteria for success, from which the DOE derived the target numbers, were based on the idea that consumers ought to be able to recoup the extra cost of a hybrid vehicle in three years, based on fuel savings alone. When the targets were developed the price of a gallon of gasoline in the U.S. was $2.65, exactly the price it is today.

To meet the DOE’s 2020 targets, the entire traction drive system for a vehicle like the Prius should add no more than $440 to the retail price of the car. Of that, $181.50 would go to the power electronics and $258.50 to the traction motor.

To illustrate just how daunting that goal is, the DOE estimated that the second generation Prius’ traction drive system added $1,925 to the retail price of a comparable non-hybrid vehicle. When you add to that the cost of the battery at $1,271 and the generator at $436, the total extra price of Prius electrification amounts to $3,632.

Obviously, the commercialization of hybrid and electric vehicles would make a whole lot more sense if the price of gasoline in the United States was considerably higher than it is today. Even at $4 per gallon, the extra cost of today’s hybrid vehicle would take consumers 6.1 years to pay off with fuel savings, according to the forecasting firm CSM Worldwide. What the U.S. electrification effort needs more than anything right now is a fuel tax that would maintain the price of gasoline at $4 or $5 per gallon, at least. That would increase demand for electric and hybrid vehicles, lead to a reduction in CO2 emissions, and make the country less dependent on foreign oil. But many consumers are dead set against new taxes, and the U.S. Congress is unlikely to consider an increase in fuel taxes any time soon.

Mitchell Olszewski, director of the Power Electronics and Electrical Power Systems Research Center at the Oak Ridge National Laboratory, is responsible for overseeing the DOE-funded research on power electronics and electric machines aimed at meeting not only the DOE cost targets but also its size and weight targets. He described some of the most promising innovations in inverters and the traction motors they drive.

Second Generation Prius Electrification Retail Cost Distribution

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generator</td>
<td>12%</td>
</tr>
<tr>
<td>Battery</td>
<td>35%</td>
</tr>
<tr>
<td>Power electronics and electrical machinery</td>
<td>53%</td>
</tr>
</tbody>
</table>

Source: U.S. Department of Energy

Current Source Inverter

Because the battery is a voltage source component, all hybrid vehicle inverters today are voltage source also. But voltage source inverters require a huge bus capacitor to absorb the ripple current that would otherwise damage the battery. The problem is that the bus capacitor alone
Internet Protocol,” specifically versions of Ethernet and FlexRay. The researchers aim to reduce complexity in in-vehicle IT architecture and at the same time guarantee operational security and ensure that future IP-based networks can deliver the full range of functionality provided by today’s traditional bus systems. BMW Group Research and Technology is the project leader, coordinating the efforts of 11 partners including Audi, Daimler, Volkswagen, Bosch and Continental.

This past August, the AVnu Alliance, a group whose members include Harman International, Apple, Broadcom, Cisco Systems, Samsung and Xilinx, began promoting standards-based A/V networking that would bring Ethernet to the automobile. The group is promoting the adoption of IEEE 802.1 Audio Video Bridging (AVB) standards and the related IEEE 1722 and 1733 standards, not only for applications in the car but also in consumer electronics and professional applications. The group intends to issue standards for low-latency applications like those found within an automobile. Unlike MOST, AVnu would be nonproprietary and low cost.

“AVnu will replace MOST in the car,” predicted Dinesh Paliwal, CEO of Harman International.

Field programmable gate array market leader, Xilinx is a founding member of AVnu and a key supplier to Harman. Xilinx already offers an Ethernet AVB Endpoint Core that provides reliable, low latency Quality of Service for live audio and video data. Xilinx’s two biggest automotive applications are infotainment and driver-assistance systems.

The time triggered data communications company TTTech Computertechnik AG has introduced TTEthernet, a real-time Ethernet technology platform that could hypothetically replace FlexRay in real-time applications that require bandwidths greater than 10 megabits per second, for example driver-assistance systems that employ multiple cameras.

“There are a few carmakers who [like BMW] haven’t yet put FlexRay into production are thinking about the possibility of bypassing FlexRay and going directly to TTEthernet,” said Markus Plankensteiner, TTTech director of marketing. “The big advantage of TTEthernet is that it supports the normal traffic you have in a car, for example for diagnostics or multimedia, but also traffic that today is communicated on CAN buses or FlexRay buses.”

Electrification... takes up as much volume as the DOE’s 2020 target for the entire inverter: about four liters. So the Center has developed and demonstrated a prototype current source inverter that reduces the volume of that capacitor down to 10% of its present size. “The reason no one has heretofore even looked at current source inverters is that they are not usually capable of regenerating the battery or powering the motor at low speeds. So the real innovation was an interfacing circuit that allowed those two objectives,” explained Dr. Olszewski.

✦ Inverter Packaging
The Center has been developing new semiconductor device packaging techniques that keep the IGBTs (insulated gate bipolar transistors) and diodes sufficiently cool so that a separate low-temperature cooling system is not needed. A separate cooling system like the one in the Prius maintains the coolant at 65 degrees C and adds about $175 to the retail price of a hybrid vehicle. It also adds volume and weight. Instead, the same 105 degree C system that cools the engine could be extended to also cool the inverter. But with standard 150 degree C trench gate IGBTs there is not much margin for error. The cooling requirement will be less difficult once next-generation IGBTs that can reliably withstand junction temperatures of 175 degrees C are widely available at a good price.

✦ Rare-Earth Magnet Sourcing
Today’s Toyota and Honda hybrid vehicles employ interior permanent magnets. But with standard 150 degree C trench gate IGBTs there is not much margin for error. The cooling requirement will be less difficult once next-generation IGBTs that can reliably withstand junction temperatures of 175 degrees C are widely available at a good price.
magnet traction motors that use rare-earth permanent magnets. “China controls 95% of the global supply of the material from which rare-earth permanent magnets are made,” cautioned Dr. Olszewski. “While costs are going up, people are even more concerned about the uncertainty of supply. Chinese production of hybrid and electric vehicles is expected to grow substantially, and that could potentially consume all of China’s rare-earth magnet production. The magnets alone represent one-half or more of the 2020 target price of the traction motor.”

The Center is attacking the problem with research from three different perspectives: minimizing the magnet requirement, employing non-rare-earth magnets and using no magnets at all. If magnets become too expensive the industry could use AC induction motors instead, but those are 15% to 20% bigger in weight and volume. Switched reluctance motors could also be considered but they are complicated to control.

The Promise of Commercial Vehicle Electrification

The business case for light vehicle electrification in the United States has been a complicated one, and the financial hardships of Ford, and especially Chrysler and General Motors, kept them from investing heavily in hybrid vehicle technology until recently. As a result there are only a few U.S. suppliers of inverters and traction motors, among them Remy International and Phoenix International.

Formerly a division of GM, Remy recently launched a new business unit that is accelerating its investment in traction motors. Phoenix International, a unit of John Deere, has an inverters business and is developing control techniques for the three motor types—rare-earth permanent magnet, AC induction and switched reluctance.

In September 2009, Remy and Phoenix International were jointly awarded a $60.2 million matching funds grant from the DOE to develop and build in the U.S. a family of matching inverters (Phoenix) and motors (Remy). Remy presently has enough manufacturing capacity to build 100,000 traction motors a year, all outside the United States, much of it unutilized. With the DOE grant, it will add approximately 80,000 units of U.S. capacity.

Since 2003 Remy has produced 75,000 traction motors. Customers include Allison Transmission, for a transit bus application and a new 10-year contract for commercial hybrid trucks, plus General Motors, Daimler and BMW for passenger vehicle applications.

In January GM announced plans to make traction motors in house starting in 2013. Toyota, which has sold 1.2 million Prius hybrid vehicles worldwide since 1997, makes its own permanent magnet motors. Honda does as well.

Despite the fact that it is hard for most U.S. consumers to justify an investment in a hybrid or electric vehicle at present gas prices, “All the major carmakers are going forward now with hybrid and/or electric vehicles,” declared Kevin Quinn, in charge of Remy’s newly formed traction motors business unit, “and we see lots of emerging companies that are going electric or doing conversions—companies like Bright Automotive, AMP Electric Vehicles, Fisker and Tesla. If volume goes up enough to bring costs down, or if gas prices go up significantly, they will be positioned to take advantage. Right now we are spending a lot of time working with the heavy duty market including truck, bus, agriculture and construction. The economics are better there, for example, in delivery vehicles that do a lot of stopping and starting.”

Phoenix International also sees promising electrification opportunities now in commercial markets and military markets as well. “Some customers in those industries can see payback in as little as one or two years,” said Kevin Larson, who is responsible for power electronics sales and marketing at Phoenix. “For example, getting fuel to where it’s needed in some military applications can make gasoline cost 100 times what it costs at a gas station.”

“Here in Wisconsin, Oshkosh Trucks has successfully introduced hybridization not only in combat vehicles but also in garbage trucks,” noted Thomas Jahns, University of Wisconsin professor of electrical engineering, and an electric machines and drive systems expert.

IGBTs Crucial

The most expensive and probably the most crucial components in inverters are the IGBTs. Many automotive IGBTs are made by the Japanese suppliers Mitsubishi Electric and Fuji Electric Systems. IGBTs are so crucial to hybrid and electric vehicles that Toyota makes them in house.

Fairchild Semiconductor, a U.S. supplier, makes IGBTs but not for automotive applications. Another U.S. firm, Allen Bradley, a division of Rockwell, makes IGBTs but not yet for automotive applications.

IGBTs could in the future be replaced by MOSFETs or JFETs made from wide bandgap semiconductors such as silicon carbide (SiC) or gallium nitride (GaN), which are capable of performing at much higher temperatures. That would significantly lessen the inverter’s cost and its cooling requirements.

But, said Dr. Olszewski, wide bandgap semiconductors are too expensive today and will remain so for at least five more years. “If silicon carbide switches could be produced for the same cost as silicon or even only a 10% penalty, carmakers would go for them because they are more efficient. The major cost issue with silicon carbide is you have to put it down on a silicon carbide substrate. GaN devices can be put down on silicon, so they have a cost advantage over SiC. And GaN can operate at higher frequencies, which gives you some reductions in ripple currents and therefore some savings in the capacitance requirements,” he explained.

For more about Dr. Olszewski’s Power Electronics and Electric Machinery Research laboratory, please visit http://peemrc.ornl.gov/about.shtml. 
Background

Harman International is the creation of Dr. Sidney Harman, who in 1953 partnered with Bernard Kardon to make FM tuners. Harman Kardon produced the world’s first monaural hi-fi receiver in 1953, followed five years later with a stereo receiver. Harman is a company built on acquisitions, starting with JBL in 1969. Over the next twenty years seven more companies were added—including Infinity, Lexicon, Madrigal, maker of Mark Levinson audio systems, and the German company Becker in 1995.

The acquisition of Becker formed the basis of Harman’s market-leading automotive infotainment business. Harman has not made an acquisition since its 2004 purchase of QNX Software Systems. Now that its balance sheet is healthy, there is a good possibility Harman could make a small technology acquisition in the next six to 12 months, but don’t look for a major acquisition as long as Dinesh Paliwal is CEO of the company. “There will be no major acquisitions under my watch,” he declared. “They are a distraction and just don’t work. But I’m a firm believer in small, bolt on, tuck in, technology plays.”

Mr. Paliwal, a control engineer, spent 27 years with ABB Ltd., a provider of industrial automation, power transmission and related services. Mr. Paliwal, a control engineer, spent 27 years in the process control business.

This profile focuses on the Automotive segment of Harman, especially the infotainment systems business, which accounts for more than half the company’s revenue. Approximately 70% of Harman’s sales are automotive, a percentage that is likely to stay roughly the same in the coming years, because Harman expects each of its divisions to grow at about the same rate. Given the massive production cutbacks in the global automotive industry, Harman’s Automotive segment sales decreased 32% in fiscal year 2009. In the same period, Consumer sales decreased...
Harman Sales by Region

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Harman Employees by Region

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When asked if Harman can return to the profitable days of the past, Mr. Paliwal gave a resounding “yes.” He believes the company will return to double-digit profitability once sales return to their 2008 level of $4.1 billion. “We are well on our way to achieving that in the next twelve to eighteen months,” he said.

Including programs that Harman has already launched and new ones recently received, for example from BMW, Mercedes, Audi and Toyota, Harman says it has secured more than 20 automotive audio and infotainment projects with more than eight vehicle manufacturers. Its automotive business backlog stands at $10 billion.

More Efficient R&D Maximizes Investment, Speeds Product Development

One of the most important tasks Mr. Paliwal undertook immediately was to make Harman a more efficient and truly global company. Even before the global recession hit, a number of changes had been in the works to rationalize production and the engineering organization, but the sudden drop in sales forced the company to make the changes faster.

“Germany was a priority because Harman had grown haphazardly there over time, with no structure in mind,” said Mr. Paliwal. “We had multiple locations doing redundant R&D and using conflicting processes.” To consolidate, Harman designated two major, vertically oriented software development centers in Germany, one in Ittersbach, near Karlsbad, and one in Garching. The Garching facility opened 18 months ago and Harman plans to invest additional funds there. “Garching has access to a great engineering talent pool through the universities in and around Munich,” Mr. Paliwal noted.

In fiscal 2009, R&D expenses for the corporation were 11.5% of sales. Harman would like to drive that figure down closer to 10% of sales. Automotive R&D is now centralized in five global centers of excellence. Three of them—Ittersbach (Germany), Farmington Hills (Michigan) and Bridgend (United Kingdom)—have been part of Harman for a while. Two new facilities were established recently. One in Shanghai, China, with roughly 200 infotainment engineers, was just opened in October 2009. The other, in Bangalore, India, was opened in 2008 and employs about 300 systems engineers.

“India gives us some development speed that we can never expect to get from Germany or the United States,” said Mr. Paliwal.

In order to focus its research and development resources where they will do the most good in terms of future sales and profits, Mr. Paliwal has been making some continued on following page

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31%; Professional sales fell 21%; and Other (QNX and Corporate) was down 10%, although QNX sales grew by 3.1%. In the first half of FY 2010, Harman’s Automotive sales improved significantly, up 7% compared with the first six months of FY 2009. Consumer sales dropped 3%; Professional was flat; Other dropped 5%.

Standard & Poor’s gives Harman a credit rating of B+, which suggests that the company is vulnerable to adverse business and economic conditions but currently has the capacity to meet its financial obligations. In January 2010 Harman repaid the outstanding balance on a $223 million credit revolver.

Margin Improvements

In the three years starting with fiscal 2005, Harman produced substantial operating margins: 11.6% in 2005, 12.2% in 2006 and 10.9% in 2007. The company had booked an unprecedented number of infotainment system awards, seven of which were scheduled to start production in fiscal 2008, with another six scheduled to start in fiscal 2009. As a result, R&D expenses ballooned from $356.7 million in 2007 to $395.9 million in 2008, and 2008’s operating margin shrank to 3.4%. In fiscal 2009, with sales off 30% from the prior year due largely to the global recession, Harman’s operating loss was $509 million.

Major Automotive Customers FY 2009

#1 BMW and Audi/VW, each with 15% of sales*
#2 Daimler, 8%
#3 Chrysler, 6%
Others listed alphabetically:
Ferrari
Porsche
Hyundai
PSA Peugeot Citroën
Land Rover
SsangYong
Lexus
Toyota

*For the six months ending December 31, 2009, BMW accounted for 18% of sales; Audi/VW accounted for 13%.

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Harman’s Competitive Strengths

- Harman is very well established at the high end of the infotainment business, a market it now dominates.
- Harman brands have the largest share, 45%, of branded automotive audio business, more even than Bose.
- A recently announced infotainment deal with Toyota marks Harman’s further penetration into the mid-level part of the market, where portable devices will increasingly be used to provide connectivity to the outside world, including the Internet.
- Harman’s in-house company, QNX, is the world’s number-one supplier of automotive operating systems and middleware. Harman and QNX are benefiting from Microsoft’s de-emphasis of its automotive business. Microsoft’s automotive software platform competes with the QNX CAR platform.
Bangalore is a SPICE maturity level five facility.

Harman has also been busy optimizing its global production footprint. In the United States the facility in Martinsville, Indiana was closed. Production that had been done in Northridge, California was moved to existing plants in Franklin, Kentucky and Washington, Missouri.

In Germany, Harman is centralizing production in Ittersbach, Straubing and Woerth-Schaidt. Some work that was being done in Hildesheim and Hechingen was transferred to third-party partners.

According to Mr. Paliwal, the company is 75% of the way toward addressing its cost inefficiencies. “I’ll be done with those by June 30,” he said. “We are a more nimble and cost efficient company. Even if European automotive unit production is down somewhat in 2010 we would make a profit.”

High-End Market Leadership

Harman has been a leading player in the high-end infotainment and audio systems market for more than a decade. With recent awards from BMW, Mercedes and Audi, won at the expense of Bosch and Continental, Harman’s two closest rivals for business with the German carmakers, Harman can justifiably claim to be the world’s number-one high-end infotainment supplier.

BMW

In September 2009, Harman was selected by BMW to provide the next-generation, high-end infotainment system for all new vehicle platforms. The Harman system includes 3D navigation, bold graphics, Internet access, and wired or wireless connectivity for all passengers. Production starts in 2012 and continues for five years, at least. Harman now has all of BMW’s European and North American infotainment business. Alpine supplies BMW’s Asian requirements using Harman’s designs and software.

Audi

Harman was recently awarded the contract to build Audi’s next-generation, high-end infotainment system. Production starts in 2012. Harman has all of Audi’s infotainment system business.

Mercedes

Last September, Mercedes awarded Harman its next-generation COMAND infotainment system for S- and C-Class models. Harman, who shares Mercedes’ infotainment system business with Mitsubishi Electric and Alpine, has about 40% of the total.

Chrysler

Harman had been supplying both the high- and low-end versions of Chrysler’s MyGig infotainment system but was losing money on the low-end systems. It recently won an agreement from the carmaker to exit the loss-making portion of the business as of December 31, 2009. Harman will build Chrysler’s next generation high-end infotainment system.

Breakthrough: Toyota Order for Mid-Market Infotainment System

Well established as the dominant player in high-end infotainment systems, Harman recently won a major award from Toyota Europe for an infotainment system based on a new single-chip Harman platform that brings many of the features available in high-end systems to mid-priced vehicles. With the new mid-level platform Harman is now able to bring products to market in half the time: one year vs. two or more years, and at half the OEM price: $500 or so vs. $1,000 and up for some high-end systems. Announced in
the fall of 2009, Harman’s mid-level infotainment platform is targeting a $5 billion market of which Harman expects to win a 20% share.

The Toyota system Harman will build is a 3D navigation-capable multimedia head unit with hands-free connectivity to mobile devices. More feature rich than most Japanese infotainment systems, it includes speech recognition and text to speech software from Nuance, which Harman sees as best in class. Shipments are to begin in early 2011 for some models and over the next several years as model redesigns come due, Toyota could roll out the scalable platform to all its European models. In 2009 Toyota sold 855,000 vehicles in Europe.

The award from Toyota is especially noteworthy because the carmaker in the past has strongly preferred doing business with its affiliated suppliers such as Denso and Aisin Seiki. Toyota owns approximately 25% of both Denso and Aisin Seiki, both solid infotainment system competitors.

Mr. Paliwal is very proud of this next-generation scalable infotainment system. “This is a break from our old approach of developing customized, monolithic products based on what the OEMs asked for. Those systems can’t be easily expanded—you get all or nothing. And you are always three years behind; by the time you deliver [job one] the technology is old.

“Our systems are typically 70% hardware and 30% software. We decided to develop this new product based on a modular software architecture. We wanted the best speech engine, the best navigation, the best connectivity. Our new system has 2.5 million lines of code and is about 75% software and 25% hardware. It is software driven so you can make adaptations as you wish. This is what Toyota wanted.”

Customizing the HMI for each program was time consuming, but thanks to some new software from QNX, Harman can streamline the process using Adobe Flash, a standard multimedia platform that lets developers program graphical applications in a fraction of the time it takes to write an implementation in C++, which is the typical way of doing it.

In the past Harman also spent a great deal of development time integrating navigation features into its systems, which can be extremely time consuming, particularly when vehicles are simultaneously launched in Europe, North America and Asia. For the new mid-level platform, Harman developed a language-independent API called Open Nav, which lets engineers quickly drop in the best navigation system for the region. For China, navigation software could come from Nuosoft; for India it could come from Map My India. Harman, Elektrobit or Nav N Go software can be integrated to cover other regions.

Harman’s newest infotainment systems are based on digital service interface structure, which means the APIs are clean and open, allowing the company to share developments among different in-house teams and integrate third party applications.

Designed to take advantage of powerful single-chip processors, the system is not dependent on any particular chip architecture. At present, an ARM-based core or an Intel Atom processor can be employed.

Genivi

With one of its divisions, Xsys, a member of the Genivi alliance and a participant in its development, Harman is closely watching the potential of the open-source development project to affect the market that Harman now leads. Genivi aims to standardize core infotainment services, middleware and application interfaces, an effort which has the potential to bring down the cost of infotainment systems. Genivi will be based on the Linux operating system.

While top Harman executives say they would welcome the opportunity to focus more on innovation and less on redoing the nuts and bolts of the infotainment system framework, they worry about quality. “That is the challenge for Genivi, something that the open-source community isn’t necessarily known for,” said Sachin Lawande, CTO of Harman International and former chief software architect for Harman Becker. “Automotive expectations are much more stringent. But let’s give it a chance. It is a good effort, a good direction, we are definitely supportive.” Genivi’s chief advocate is BMW who has given Harman nearly all of its infotainment business.

continued on following page
Harman International

QNX Software Systems

**FY 2009 Sales:** $52.9 million  
**Automotive Sales:** About 36% of total sales. Harman is the largest automotive customer, accounting for about 55% of automotive sales.  
**Headquarters:** Ottawa, Canada; www.qnx.com  
**Products:** Middleware, development tools and operating systems  
**Employees:** About 270  
**FY 2009 ended June 30, 2009**

QNX Sales by Fiscal Year

<table>
<thead>
<tr>
<th>Year</th>
<th>Sales in $ millions</th>
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<tbody>
<tr>
<td>2007</td>
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<tr>
<td>2008</td>
<td>51.3</td>
</tr>
<tr>
<td>2009</td>
<td>52.9</td>
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Source: QNX

Automotive Applications of QNX Software

- More than 12 million vehicles are on the road with QNX-licensed software including these applications:
  - Next-generation COMAND infotainment systems for Mercedes S-Class and C-Class models
  - Next-generation BMW 7 Series infotainment system
  - BMW car infotainment computer
  - BMW (all models) telematics box
  - Audi third-generation MMI infotainment system
  - Audi 2011 A8 navigation system with Google Earth capability
  - 2010 Range Rover and Jaguar XK digital instrument clusters from Visteon
  - OnStar by General Motors
  - Porsche Communication Management (PCM) system
  - Renault Samsung SM7 NIS-700 infotainment system
  - Chrysler, Dodge and Jeep MyGiG multimedia entertainment system
  - Volkswagen Routan multimedia entertainment system
  - Daewoo VisionJoy navigation system
  - Hyundai Mobis MTS-1 navigation system
  - Nissan (all models) handsfree system
  - Toyota Camry handsfree system
  - Lexus ES handsfree system
  - Acura and Honda HandsFreeLink
  - Autotelligence BlueConnect aftermarket Bluetooth handsfree systems

Harman and our other customers. Customers don’t want a proprietary solution; they want a standard platform. We serve all the tier ones, so a carmaker can say, ‘yes, we want to use QNX, but we’ll use the tier one of our choosing.’”

QNX CAR

- Introduced in February 2009 and already being used by several carmakers, QNX CAR is a fully featured infotainment and instrument cluster platform that includes operating system, middleware and application programming interfaces. Harman will use QNX CAR for all of the infotainment system business it has booked, both high-end and mid-level systems. QNX reports that “globally 13 car manufacturers and 21 tier ones are participating in the QNX CAR program for both digital instrument clusters and infotainment systems.”

The QNX CAR platform consists of a reliable real-time operating system, QNX Neutrino, along with reference implementations and tools with which to build touch screen user interfaces. Included in the platform are: streaming media players for things like YouTube video and Pandora Internet radio; navigation systems with Google search; Bluetooth and portable device connectivity; multimedia playback; hands-free integration; climate control; Adobe Flash games; application store technology; and a virtual mechanic. The platform also includes a reference application to do Nuance voice recognition either onboard the vehicle or via a back-end server.

Carmakers can choose to use the entire platform with all of the reference implementations pre-integrated, or they can pick only the components they need from an à la carte menu to lower costs.

The only other “standard” platform on the market thus far is Microsoft Auto, used by Fiat and Ford, and soon by Kia, but it doesn’t support nearly as many applications as QNX CAR. Two other infotainment platforms are in the works, but they are not yet completed. One is the Genivi open-source development instigated by BMW, GM, PSA and Nissan. The other is a platform based on the QNX operating system being developed by e.solutions, a joint venture between Audi Electronics Venture and the Finnish software company Elektrobit (EB).

QNX CAR supports existing graphics standards including Adobe Flash Lite 3.x, OpenGL ES, and Open VG; and it supports WebKit, an open source Web browser engine. “There is a large set of applets that have been developed for Flash,” said Mr. Dodge. “With this, consumers can bring some of those applications to the car. We can also run Google APIs, and now we have Android running in our labs to explore its suitability for automotive.” Developed by Google, Android is a smartphone operating system. To learn more about QNX CAR, visit www.qnx.com/qnx_car_portal. •