GM’s Global E/E Boss Weighs In

Frischkorn on Global Product Development, Software and Suppliers

We had an interesting conversation recently with Hans-Georg Frischkorn, who transferred from BMW in April 2006 to become GM’s executive director of global electrical systems, controls and software. He is responsible for the design, engineering and release of all electrical and electronics parts and software, including architectures for electrical functionality, serial data and diagnostics, but not including powertrain controls or research.

Since he has been on the job for almost a year we thought it high time to ask him how electrical engineering is changing at GM under his guidance and what suppliers can do to help.

One of the things that attracted Mr. Frischkorn to GM was the carmaker’s newly established global engineering organization. “That is one of the major changes that GM has undertaken in product development. We are very focused on developing electrical and electronics subsystems that will be used throughout the world—in North America, South America, Europe, Asia Pacific and Australia.”

Mr. Frischkorn pointed out that the emphasis on global engineering at GM comes from the very top. GM chairman and CEO, Rick Wagoner, in a speech at Convergence 2006 highlighted a new program he believes exemplifies GM’s commitment to operating our business as a truly integrated global company.

Global A Electronics Modules

An extremely important outcome of this global orientation that will affect GM’s global engineering. "That is one of the major changes that GM has undertaken in product development. We are very focused on developing electrical and electronics subsystems that will be used throughout the world—in North America, South America, Europe, Asia Pacific and Australia." Mr. Frischkorn pointed out that the emphasis on global engineering at GM comes from the very top. GM chairman and CEO, Rick Wagoner, in a speech at Convergence 2006 highlighted a new program he believes exemplifies GM’s commitment to operating our business as a truly integrated global company.

Japan Out Front in Car-to-Infrastructure Communications

Nissan Safety Field Trial Already Underway

“I strongly believe—and Daimler-Chrysler strongly believes—that communications is the next logical step in vehicle safety,” declared Weiland Holfelder, vice president and chief technology officer of DaimlerChrysler research, engineering and design North America. “We have ABS, electronic stability control and adaptive cruise control. What is missing is that vehicles cannot talk to each other, and they cannot talk to the infrastructure. ... It is enabling technology that will open up so many additional things ... like the Internet. It’s going to happen.”

While there has been some research and a lot of talk in Europe and the United States about car-to-x communications, no significant field operational tests are scheduled for the near term. One of the earliest we are aware of isn’t directly focused on intersection crash avoidance, but on floating car traffic-data collection. A €30 million German initiative called SIM-TD (Safe Intelligent Mobility and Test Region/Field Deutschland), this field operational test (FOT) involving 500 to 2,000 vehicles will evaluate automotive communications platforms. The testing could get underway in the next couple of years, but results wouldn’t be ready until Turn to Communications, page 8

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2006 Roundup: Siemens VDO, TRW, Valeo, Visteon

Siemens VDO: Automotive
Fiscal year ending September 30, 2006
2006 Sales: €10,017 million ($13,213 million)
Change from 2005: up 4.2%
2006 Profit: €669 million ($870 million) or 6.7% of sales, roughly the same margin as in 2005
In late January 2007, Siemens AG announced that it was preparing to spin off a minority stake in Siemens VDO Automotive through an IPO. Some analysts expect the offering to take place in the second half of this year.

Siemens VDO reorganized its business divisions in October 2006 into these four: Powertrain, Interior Electronics and Infotainment, Safety and Chassis, and Commercial Vehicles. In fiscal 2006, Siemens VDO’s ten largest customers accounted for 80% of sales. Nearly two-thirds of sales were from Europe, with one-third in Germany alone. The remaining third of sales was primarily generated in the United States.

Siemens VDO is marketing a family of active safety products—LIDAR-based adaptive cruise control, night vision, blind spot detection and lane departure warning—under the name pro.pilot. In September 2006 the company introduced a drowsy driver monitoring system that uses an infrared camera to monitor the driver’s face, which in the future could be integrated with other pro.pilot features.

The company announced in December 2006 that it is acquiring Ballard Power Systems’ electric drive business for $4 million.

TRW: Automotive
2006 Sales: $13,144 million
Change from 2005: up 4%
2006 Net Profit: $176 million, or 1.3% of sales, down from $204 million in net earnings in 2005
Outlook for 2007: Net sales are expected to increase slightly, to between $13.4 billion and $13.8 billion. TRW expects to benefit from increased sales of U.S.-mandated safety products including direct tire pressure sensing, occupant sensing and the phase-in of electronic stability control systems proposed by NHTSA.

The company attributes 2006 sales growth in part to its 2005 acquisition of the steering wheel and airbag maker Dalfimetal, which serves European carmakers including Peugeot, Renault, Volkswagen and Volvo.

TRW’s largest business segment, Chassis Systems, accounted for 54% of 2006 sales; Occupant Safety Systems, 33%; Automotive Components, 13%. More than half, 57%, of TRW’s sales are in Europe; North America accounted for 33% of sales.

TRW’s number one OEM customer in 2006 was Volkswagen Group, which accounted for 15.5% of sales. Sales to Ford Motor Co., the largest customer in 2005, contributed 14.6% of total TRW sales.

Valeo
2006 Net Sales: €9,970 million ($13,151 million)
Change from 2005: up 2.2%
2006 Net Profit: €161 million or 1.6% of sales, compared with net profit of €142 million or 1.5% of sales in 2005
Valeo’s largest product lines, climate control and engine cooling, together accounted for 31% of sales.

In December 2006 Valeo sold its Electrical Motors and Actuators business to Nidec, a Japanese motor manufacturer, for €142 million. Valeo increased its investment in the Japanese lighting supplier Ichikoh to 29.4%, and increased its investment in the Japanese lighting supplier Raytheon Systems to 77.2%.

Subject to reaching agreement with the United Auto Workers, Valeo will acquire Ford’s Thermal Systems plant in Plymouth, Michigan. With 2006 sales of approximately €350 million ($462 million), the facility employs 1,250 people.

At the end of 2006, Valeo had 129 production facilities, with 54% of its production workers located in low labor cost countries.

Visteon Corp.
2006 Net Sales: $11,418 million
Change from 2005: down 32.7%
Visteon has never shown an annual profit.

2007 Sales Outlook: Visteon estimates net loss between $267 million and $367 million on sales of $11.1 billion.

Visteon considers interiors, climate controls and electronics, including lighting, its core product areas where it will focus investment. In 2006 segment sales broke down as follows: Climate, $3 billion; Electronics, $3 billion; Interiors, $2.8 billion. Sales in Electronics and Interiors declined nearly 6% compared with the prior year.

Ford remains Visteon’s largest customer, accounting for 45% of product sales in 2006, down significantly from 62% in 2005.

Visteon reduced its R&D expenditure from $804 million, or 4.7% of sales, in 2005 to $594 million, or 5.2% of sales, in 2006. A part of the company’s ongoing restructuring, eleven plants were fixed, closed or sold in 2006; seven more are scheduled for sale or closure in 2007. Visteon eliminated 800 salaried positions in the fourth quarter. According to the company, 80% of its $1 billion of new business wins will be manufactured in low labor cost countries. Pardus Capital Management, which owns 10.2% of Visteon, recently increased its stake in Visteon to 17.4%.

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automotive electronics is GM’s Global A program, which will encompass every electronics module in the car, including chassis control. In his Convergence speech Rick Wagoner explained: “The idea behind Global A is to create a small number of highly integrated, high-volume, common electronic modules and devices, designed to cover the full bandwidth of GM vehicles across the globe.

The advantages to us are huge: massive economies of scale, reduced cost, improved warranty performance, smoother launches and better use of engineering resources. And for our suppliers—significantly larger orders.”

“The first GM vehicles with Global A modules will be on the road within two years,” noted Mr. Frischkorn. “Each engineering center will use the same body controllers, the same radios, the same navigation devices and the same airbag control module across multiple car lines.”

GM will use just three Global A radios: a simple radio, a mid-level system with a small display and CD player, and a fully-equipped head unit with speech recognition and full 3D map. Depending on the region where it will be used, each module will have slight variations in HMI (human machine interface) and other features. For example, European radios make greater use of TMC (traffic message channel) features than do other regions.

There will also be just three body control modules in the Global A program. Airbag-controller modules are also highly commonized. According to Mr. Frischkorn, “The difference from airbag to airbag is the number of [airbag] loops and whether you have an integrated rollover sensor.”

While Global A doesn’t encompass the powertrain controller itself, it does comprehend the powertrain electrical interface, which is a set of protocols jointly owned by GM’s Powertrain and Electrical Systems engineering organizations, that allow engine and transmission systems to communicate with other vehicle systems.

Because it will take more than three years to roll out Global A modules across GM’s vehicle lines, the carmaker will not be an early adopter of AUTOSAR, the software architecture standard being promoted by BMW and others. Rather, “AUTOSAR will be GM’s next step in the evolution of architectures,” said Mr. Frischkorn. Unlike AUTOSAR, the Global A architecture doesn’t use standard middleware. As such, the middleware from each Global A module supplier will probably be different. Global A architecture further differs from AUTOSAR in that it is not the same across all domains. For example, the Global A body-control module architecture is not the same as the Global A architecture of the radios and airbag controllers.

GM-Made Software

While Global A should have a significant impact on unit volumes and prices of GM’s electronics modules, GM’s policy to develop the application software and HMI software that will run in those modules will have a greater effect on GM’s suppliers because GM will be turning in-house for what it used to buy on the outside.

“Since means we will now be sourcing only hardware, which means we can open up competition to all regions of the world and not just rely on those suppliers capable of doing the whole system including all functionality and testing,” explained Mr. Frischkorn.

At present, somewhere between 100 and 200 software engineers are in Mr. Frischkorn’s organization, but that number will double in the next two years. GM’s North American and European software operations will see some growth but the most dramatic increase will come at GM facilities in India. Additional software engineers are employed within GM’s Powertrain organization.

While GM is investing heavily in software development, the carmaker will not be writing all of its software. One area where it will continue to rely on suppliers is airbag software. GM is also disinclined toward writing its own middleware unless what is available commercially is insufficient. “Any software that’s core to the way the customer experiences the car, like HMI, or software that’s innovative in active safety, like sensor fusion, or telematics, we want to do that ourselves over time,” summarized Mr. Frischkorn.

System Integration of Complex Functionality

A third major trend underway at GM, according to Mr. Frischkorn, is a commitment to taking systems engineering to the next level. “We are strengthening our systems engineering approach to subsystem integration, advanced validation technologies and architectures. A part of this, we are very strongly endorsing CMMI,” he said.

GM’s objective is to be at CMMI (Capability Maturity Model Integration) level 3, though the particular level is only part of the story. More important, according to Mr. Frischkorn, is “really making sure that everybody involved works through that process and is involved in a structured continuous improvement process. While that does involve some tools and education, such a cultural change is best accomplished by working through pilot projects—showing the benefits of these and then engaging more and more people in the organization.” For more on CMMI please visit www.sei.cmu.edu/cmmi.

How Suppliers Can Help

If there is one thing that suppliers can do to increase the likelihood of doing business with GM, it’s strengthening their process capabilities. Mr. Frischkorn elaborated: “The better the suppliers are at delivering high value functionality on time, on cost and with quality, the more they help us. At the end of the day, that capability is the only thing that counts.”

A better way to win at GM is with new and innovative infotainment technology. “We are very interested in intelligent plug-and-play integration of portable devices. [We are also interested] in Wi-Fi communications and in new HMI concepts,” declared Mr. Frischkorn.

“While GM is very much cost-driven these days, given our financial situation, increasingly we are very interested also in co-development partnerships with innovative suppliers,” noted Mr. Frischkorn. “We’ve got contracts for that.”

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The Company Profile...

Garmin Ltd.

Background

When Gary Burrell and Min Kao founded Garmin in 1989, the U.S. Department of Defense was intentionally degrading the accuracy of GPS (Global Positioning System) satellite signals for civilian commercial purposes to a radius of about 100 meters, a practice known as Selective Availability. Nevertheless, it was the Garmin founders’ vision that GPS would eventually “change the face of navigation” and they began designing GPS equipment in 1990. Selective Availability was permanently discontinued in 2000, and today Garmin GPS receivers achieve an average accuracy of approximately 10 meters. Some of the newer receivers that include Wide Area Augmentation System (WAAS) technology are accurate to within three meters.

WAAS improves the accuracy of GPS through ground reference stations and additional satellites.

Garmin’s navigation devices are widely used in aviation, marine, automotive and recreational applications. Garmin shipped a total of 5.4 million navigation units in 2006, up 80% over the prior year. Cumulatively since its founding, Garmin has shipped more than 19 million navigation devices. In all its business segments Garmin introduced more than 70 new products in 2006, following 40 new products in 2005.

In contrast with most automotive suppliers, who have had trouble making profits lately, Garmin’s balance sheet is very strong. At year-end 2006, current assets exceeded current liabilities by $831 million, and long-term debt was miniscule, just $248,000.

Garmin’s revenue and earnings per share grew during 2006, by 73% and 64% respectively. The Automotive/Mobile segment’s fourth quarter sales were up 173% over the fourth quarter in 2005. Garmin expects Automotive/Mobile sales to grow by 50% in 2007.

In 2006, Forbes magazine named Garmin “America’s best managed company in the field of technology hardware.” In 2006 Garmin hired 250 engineers and plans to hire an additional 250 engineers...
in 2007. None of Garmin’s employees are represented by a labor union or covered by a collective bargaining agreement.

Garmin’s design and manufacturing processes are certified to ISO 9001:2000 quality standards. Aditionally, Garmin’s manufacturing facility in Taiwan has achieved TS 16949:2002 automotive supplier quality certification.

It’s hard to say exactly what Garmin’s nationality is. The company was founded in Kansas and world headquarters, R&D, and a large manufacturing facility are located in Olathe, Kansas. The company’s two founders, Gary Burrell and Min H. Kao are both U.S. citizens.

According to the company’s SEC filings, “Garmin Ltd. [the parent] was incorporated in the Cayman Islands [a tax haven] on July 24, 2000 as a holding company for Garmin Corporation, a Taiwan corporation [and subsidiary of Garmin Ltd.].” Garmin Ltd. went public in December 2000. A substantial portion of Garmin’s assets are located in Taiwan, where more than half the employees reside. Garmin chairman and CEO, Dr. Kao, who has M.S. and Ph.D. degrees in electrical engineering from the University of Tennessee, also has a degree in electrical engineering from National Taiwan University.

**Garmin R&D Expenditures by Year**

- 2002: $32.2 million
- 2003: $43.7 million
- 2004: $61.6 million
- 2005: $74.9 million
- 2006: $113.3 million

**Garmin’s Principal Competitors with Portable Automotive Products**

- Alpine Electronics
- Audiovox
- Clarion
- Cobra
- Magellan Navigation
- Mio Technology
- Navman
- Pharos
- Pioneer
- TomTom
- Sony

**Distinctions Claimed by Garmin**

- Number-one market share of personal navigation devices in the U.S.
- Number-two market share of personal navigation devices in Europe
- Has an exclusive deal with seven of the eight major car rental companies in the U.S.
- Sixteen consecutive years of business growth
- The leader in GPS innovation: offers more products than any other automotive navigation manufacturer
- Created the world’s first portable GPS with moving maps, August 1993
- Created the world’s first PDA with GPS technology, 2002
- Created the world’s smallest GPS unit for outdoor enthusiasts, 2006

**Embedded vs. Portable Navigation Devices**

Much of the appeal of Garmin products is their portability—buyers can use them in more than one vehicle. Demand for portable navigation devices is definitively outpacing the demand for embedded navigation systems. That trend toward portability, says Ted Gartner, Garmin’s media relations manager, compares with car phones: “How many car phones do you see these days?”

A big advantage portable navigation device makers have over their embedded navigation device rivals is speed to market. Mr. Gartner remarked, “A car gets developed over the course of several years, whereas our PNDs take only a year to 18 months from concept to marketplace. By the time an in-dash system hits the showroom floor it’s out of date and no longer cutting-edge compared to the Garmin PND they could get at the dealer.”

While Garmin doesn’t usually compete directly with leading makers of embedded navigation equipment such as Denso, Aisin Seiki, Alpine, Harman, Hitachi and Pioneer, its portable navigation products are taking a huge bite out of the embedded market. Good portable navigation devices, like those made by Garmin, get you where you want to go as well as the best embedded units, and they cost as little as one-third the price. And because they are portable, each household only needs one. As a result, sales of portable navigation devices have surpassed those of embedded devices and will continue to grow at a faster pace well into the future. Competition among PND suppliers is driving PND prices even lower, which will further deflate the price of embedded navigation systems.

According to the U.K.-based IMS Research Automotive Group worldwide sales of PNDs will grow from 11.3 million units in 2006 to 30.1 million units in 2010. In that same period, cell phone navigation systems, a business also served by Garmin, will grow at an even faster pace, from 7.3 million units in 2006 to about 43.8 million units by 2010. (For more from IMS, please visit www.imresearch.com.)

**Garmin Aims to Serve Global Markets**

Already the most successful navigation equipment supplier in the United States with 50% market share, Garmin has been making strides elsewhere in the world. It is currently the number-two supplier of personal navigation devices in Europe, where its sales rose 88% in 2006 to $585 million, or 33% of total sales.

Garmin has been investing heavily in building up its brand and distribution channels in Europe. For example it
Garmin Ltd.

Garmin and Carmakers, Three Ways to Relate

Dealer Accessory
A portable navigation device is packaged with the price of a new car or sold later when the customer returns to the dealer for service. This approach is taken by Ford dealers in Europe and Hyundai dealers in North America.

Dealer Installed
A Garmin industrial design team helps to integrate PNDs into the vehicle. For example, a suction-cup or bean-bag mounting can be replaced with a built-in docking system that preserves device portability. Or, as was done for Chrysler’s Mopar parts operation, a custom mount for the PND was placed in an unused niche in the dash, atop the center stack of the Dodge Nitro. The installation can accommodate connections to power and to the vehicle’s speakers. Garmin has dealer installed programs going also with Southeast Toyota and with Honda Access in Europe.

Factory Installed
In January 2006 Garmin announced the availability of its black-box, customer-configurable, hideaway navigation system, the GVN 52. Designed for integration with existing mobile audio-video entertainment systems, the GVN 52 features Garmin’s easy-to-use StreetPilot user interface. The built-in turn-by-turn, text-to-speech, voice-prompted directions can be amplified through audio system speakers. Composite video or RGB video output can be fed to an existing display. The unit can be controlled by touch screen and/or through a wireless remote. It is also compatible with dead-reckoning gear and traffic information via XM Traffic.

According to Garmin, the GVN 52 comprises the core of every navigation unit sold worldwide by Kenwood, the Japanese aftermarket navigation and audio system supplier. A version of the GVN product is factory-installed on Honda Gold Wing motorcycles, where it is integrated with the CB and audio systems and where map updates are done by way of a Compact Flash card. The GVN 52, which comes preloaded with maps of United States, Canada and Puerto Rico or Western Europe, but doesn’t include the display, bears a manufacturer’s suggested retail price of $599.

Why Garmin?
Garmin has negotiated exclusive deals with seven of the top eight car rental companies in the United States. The eighth major player, Hertz, has been with Magellan since Hertz first began offering its NeverLost system in 1999. A recent agreement with Cinti Steiner, senior sales manager for OEM automotive accounts, is a major reason Garmin has been so successful with rental car companies is the ease of use of its products. “A person renting a car does not have time to look at an owner’s manual. Our units are very simple. We give you just two options on the main screen: ‘Where to?’ and ‘View map.’ Garmin has used the same user interface on most of its products since 2005, when it was introduced on the c330, Garmin’s first 3.5-inch StreetPilot device. “We like to say, ‘If you can use an ATM you can use a Garmin device,’” noted Mr. Steiner.

OE Sales
Mr. Steiner told us how a working relationship with Garmin can begin. “We work with our engineering and industrial design team and develop three or four concepts for vehicles that an OEM can consider. Since engineering cycles for PNDs are a little faster than in the embedded space, we can leverage our experience with products like MSN Direct and traffic detection receivers and apply those to the embedded market.” Garmin’s approach to navigation is finding traction among carmakers and dealers. By 2005 Garmin had won only three OEM programs; today it has 15 OEM programs. Garmin feels it is well qualified to help with the integration of its products into vehicles given more than a decade of experience with integrating its navigation equipment into the cockpits of airplanes.

Carmakers and dealers interested in learning more about Garmin’s products can contact clint.steiner@garmin.com.

Hottest New Features: Bluetooth and Traffic
A mong all the new features recently brought to market by Garmin, Bluetooth is hottest, along with traffic receivers. In 2006 Garmin added Bluetooth capability to several of its personal navigation devices, and now seven of Garmin’s 20 PNDs are enabled for Bluetooth wireless connectivity with scores of compatible Bluetooth phones. “The number of Garmin units with Bluetooth is expanding because of public demand,” noted Mr. Steiner. “Last year we had just one or two Bluetooth units.” The Garmin PNDs with Bluetooth features include three nüvi models, two StreetPilot models and two zumo (motorcycle) models.

With a Bluetooth-equipped PND and Bluetooth-compatible phone, users can immediately access the phone numbers of the six million points of interest stored in the PND’s memory and automatically dial that number with the push of a button on the display.

And of course with Bluetooth the PND accommodates hands-free calling; the navigation unit is equipped with a microphone and speakers. “Your display screen now displays caller ID so you can simply hit ‘answer’ or ‘ignore,’” explained Mr. Steiner. “It also supports SMS (short message service) text messaging.” The Bluetooth PND also downloads the phone
book from your cell phone for easier dialing. Garmin hands-free calling is compatible with more than 280 phone models.

Products that feature traffic information are also very hot at Garmin. Today Garmin offers three different traffic information products: FM TMC Traffic, XM NavTraffic and Traffic.com. When paired with the compatible Garmin navigation device the system provides the user with advance notice about traffic delays and offers an alternative route.

FM TMC Traffic requires an FM antenna and receiver, built into the PND or integrated into the cigarette lighter adapter. Dealer-installed or OEM versions can take advantage of the car's antenna. The traffic data, available for more than 50 markets, is aggregated by Clear Channel Communications and transmitted over FM RDS (radio data system) radio. Garmin traffic receiver/antennas retail for $214 or $160, depending on the model, and include a 15-month subscription to Clear Channel TMC for customers in North America. The large majority of traffic service users, however, purchase a unit that has the traffic receiver bundled with the unit, like Garmin's nüvi 660/680 or StreetPilot 550/680. In the U.K. and France, TMC traffic subscriptions are free.

Available in 44 markets with additional coverage coming quickly, XM NavTraffic information is aggregated by Garmin's map-data supplier, NAVTEQ. NAVTEQ gets its traffic data from many of the same sources as Clear Channel. XM NavTraffic costs $9.95 per month, plus the cost of a separate XM data receiver and antenna.

The third traffic service, Traffic.com, is available free with Garmin's Mobile 20 Smart Navigation application that runs on smartphones and is accessed via the cell phone connection to Garmin Online. Traffic.com was recently acquired by NAVTEQ.

**Garmin’s Deals with Carmakers and Car Rental Companies**

| BMW and MINI dealers in the U.K. | Multiple products |
| Chrysler, Dodge and Jeep, N.A. dealer-installed option | Navus, based on StreetPilot 2600 |
| Ford dealers in Europe | Multiple StreetPilot and nüvi units |
| Ford, Lincoln and Mercury dealers in U.S. | nüvi 680 w/ MSN Direct, nüvi 360 |
| Harley Davidson, certain models | Roadtech Quest and Conquest |
| Honda Gold Wing motorcycle | Garmin is tier-one supplier |
| Honda in Europe, dealer option on several models | Customized mount for nüvi 360 |
| Hyundai dealers in N.A. | nüvi 360 |
| Jeep Wrangler, dealer-installed option | Trail Guide |
| Saab dealers in Europe | nüvi 300 |
| Toyota FJ Cruiser, dealer-installed option | Quest (customized) |
| Southeast Toyota, port-installed option | Customized mount for nüvi |
| smart fortwo and forfour, port-installed option | Version of StreetPilot c500 |

**Exclusive Deals with Car Rental Companies**

Avis and Budget Car Rental provide Where2 navigators (based on StreetPilot c550) at 125 locations throughout the United States and Canada.

Dollar Thrifty Automotive Group offers a customized version of the StreetPilot c330 at 139 Dollar and Thrifty locations.

Enterprise Rent-A-Car offers a customized version of Garmin’s StreetPilot c340 at the company’s 100 top airport rental locations.

National Car Rental and Alamo Rent A Car offer StreetPilot c330 at more than 150 dealers in the United States and Canada.

**Automotive/Mobile Products**

**StreetPilot (15 models)**

The StreetPilot i-Series are Garmin’s smallest and least expensive PNDs. The c-Series features a touch-screen interface and turn-by-turn directions. The StreetPilot 2720 and 2820 are full-featured navigators in a different form factor. The StreetPilot 7000-Series are high-end automotive and RV units that display navigation, entertainment, traffic and weather information on a large, 7-inch touch screen.

**nüvi (8 models, 3 more coming April 2007)**

Launched in 2005, the nüvi is a portable navigation device designed for travelers. It combines into one device a full-featured GPS navigator with a language translator, MP3 player, audio book player, currency and measurement converter, world clock and digital photo organizer.

**zumo (3 models)**

Designed for use on motorcycles, zumo features a glare-resistant and glove-friendly touch screen.

**Quest (2 models)**

This pocket-size portable GPS unit is capable of automatic turn-by-turn routing and doubles as a rugged outdoor handheld navigation device.

**GVN-52**

is Garmin’s private-label embedded navigation solution in a box.

**iQue (2 models)**

This Palm OS-based PDA product line uses Garmin’s Que technology to connect the Palm Address Book and Date Book to the GPS electronic map so users can navigate directly to a specific address from their contact database or date book.

**Garmin Mobile (3 models)**

Garmin Mobile is a subscription-based software application that lets Bluetooth-enabled smartphones, laptops, Pocket PCs or PDAs function as GPS navigators.

**GPS 18 (2 models)**

GPS 18 turns a PC laptop into a GPS navigator.
Communications...  
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2010 or 2011, when the decision would be made about further investment.

The U.S. Department of Transportation is hoping to begin a 50-vehicle, 24-intersection FOT, part of its Cooperative Intersection Collision Avoidance Systems initiative, as early as the summer of 2008. A final joint decision by carmakers and the USDOT on whether or not to proceed with the test won't be made until May 2008. The FOT would take about two years.

Nissan's Vehicle-Infrastructure Safety System FOT

In October 2006, Nissan launched a major field operational test of intersection collision avoidance in Kanagawa, Yokohama, Japan. The Kanagawa test already has 1,000 vehicles participating and eventually will involve 2,000 vehicles, each equipped with a Nissan Carwings telematics platform. Carwings systems include navigation and voice assistance functions, and a VICS antenna/receiver capable of receiving infrared communications from roadside beacons. In Japan, VICS (Vehicle Information and Communications System) broadcasts real-time traffic information for major roadways to cars equipped with VICS-compatible navigation systems. The Nissan test is scheduled to be completed by March 2008. Honda and Toyota are planning similar tests.

A major function of the intersection crash avoidance system is alerting drivers approaching an intersection that an unseen vehicle is also approaching at cross paths and at a high speed. When a sensor at the intersection detects the oncoming vehicle, that information is transmitted via IR beacon to other vehicles approaching the intersection. Onboard IR receivers pick up the transmission and alert the driver with a voice message such as “car approaching from left.” A navigation screen depicting an approaching vehicle simultaneously appears on the Carwings navigation screen.

Based on some early results, the test is going very well, explained Masao Fukushima, a top engineer at Nissan. In the first two and a half months, 250 instrumented vehicles were logged going through the intersection. Twenty percent of those vehicles received information that oncoming vehicles were approaching. As a result, 60% of the vehicles that received the alert drove 15 kilometers per hour more slowly than vehicles that weren’t alerted. “I am very happy because our test depends on ordinary drivers who react to the information by driving more safely,” said M. Fukushima.

Japan Will Use Existing IR Infrastructure

Even though the Japanese government has set aside the 5.8 GHz DSRC (Dedicated Short Range Communications) RF spectrum for electronic toll collection and for next-generation road services, Nissan’s field test, as well as vehicle-to-infrastructure field tests to be conducted by Toyota and Honda, will make use of infrared beacons. The same IR beacon technology has been in use in Japan since the VICS service was first deployed in 1996. It is quite likely that IR beacons will ultimately be used when an intersection collision avoidance system is deployed in Japan in 2010. “There remains only a short time, so we must use infrared. It is really not so bad,” said M. Fukushima.

In order to receive the intersection safety communications, drivers would only need the VICS three-media antenna/receiver, assuming they already have a telematics terminal like Carwings. Today the three-media antenna retails for about $200 but could cost less when unit sales rise significantly higher. Presently about 7% to 10% of drivers opt for the VICS three-media antenna/receiver, which is designed to receive data from broadcast FM, IR beacons and 2.4 GHz beacon transmissions.

Building up the infrastructure for intersection crash avoidance will be the responsibility of the Japanese government, which would place IR beacons 100 to 200 meters in advance of each intersection. The government could equip each of the 4,000 so-called “dangerous intersections”—those with at least six deaths or injuries from accidents each year—throughout Japan, plus a few thousand less dangerous intersections.

While the benefit of avoiding collisions at intersections would nearly pay for the investment in new infrastructure, Nissan sees added value in equipping more vehicles for car-to-infrastructure communications: each of those vehicles can be used as traffic probes to collect real-time data. With traffic probe data, Nissan could provide its Carwings customers with more accurate route guidance. A part of its Kanagawa field operational test, Nissan has also equipped 8,000 vehicles as traffic data collection probes. When the test is fully underway, 10,000 vehicles will participate.

Nissan’s Kanagawa intersection collision avoidance project is also testing systems that alert the driver if his speed is too high for approaching a red traffic light, a stop sign or a primary school zone. Toyota and Honda are testing similar applications; Toyota’s traffic signal and stop sign test involving 100 vehicles got underway in December 2006. Honda’s will start in July 2007.

Garmin Leads U.S. Portable Navigation Market

<table>
<thead>
<tr>
<th>Vendor</th>
<th>2006 Shipments</th>
<th>2005 Shipments</th>
<th>Growth 2006/2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Garmin</td>
<td>1,443,150</td>
<td>389,910</td>
<td>270.1%</td>
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<tr>
<td>Magellan</td>
<td>415,160</td>
<td>181,460</td>
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<td>TomTom</td>
<td>396,530</td>
<td>100,590</td>
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<tr>
<td>Mio Technology</td>
<td>119,690</td>
<td>610</td>
<td>19,521.3%</td>
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<tr>
<td>Lowrance</td>
<td>66,420</td>
<td>32,720</td>
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<tr>
<td>Others</td>
<td>426,870</td>
<td>71,990</td>
<td>493.0%</td>
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<tr>
<td>Total</td>
<td>2,867,820</td>
<td>777,280</td>
<td>269.0%</td>
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Source: Canalys