Cost of Radar Is Going Down

SiGe Sensors by 2008

Most innovation in automotive electronics comes from the semiconductor industry. Improvements in silicon germanium (SiGe) technology will soon lead to radar sensors that are significantly more affordable than sensors made using gallium arsenide (GaAs), which is what they will replace. GaAs semiconductors are far more difficult to build than those made from SiGe.

What’s remarkable about silicon germanium is that semiconductors made using the material can be produced on the same lines, using the same processes, as those used to make silicon integrated circuits, and they function very well at frequencies that are way too high for silicon. In June 2006 a research team from IBM and Georgia Institute of Technology demonstrated a SiGe transistor operating at 500 GHz, a record. The first radar sensors made using a SiGe chip set will operate at 24 GHz, nowhere near the record.

The great benefit to the auto industry is that radar sensors made from SiGe will eventually cost as little as $20 each, roughly one-fifth the OE price now paid for sensors made from GaAs. Radar sensors are comprised of an RF (radio frequency) front-end, which contributes about 50% to the sensor’s cost, and a digital signal processor for computation, perhaps 35% of the cost. The packaging of the sensor and software account for the rest.

With the RF part done in SiGe, not only will it be much smaller and cheaper, but some of the circuits that had been separate can now be integrated on the same lines, using the same processes, as those used to make silicon integrated circuits, and they function very well at frequencies that are way too high for silicon.

Hughes Telematics Makes Business Case

First OEM Customer: Chrysler

Knee-deep in a program to deliver an end-to-end solution for the Chrysler Group by the 2010 model year, Erik Goldman, president of Hughes Telematics Inc., thinks the time is finally ripe for telematics. “I’ve been watching the telematics space since the 1990s. I’ve seen it rise. I’ve seen it fall. I’m very familiar with some of the strengths and weaknesses of the historical model. There’s a unique opportunity with the resources we have through A pollo Management, the resources we have through Hughes Communications, the progress that OnStar has made, and the real efficiencies that technology can now deliver,” said Mr. G. Goldman from the company’s headquarters in Atlanta, Georgia.

Hughes Telematics is majority-owned by A pollo Management, a private equity firm with $27 billion of capital under management. In the mid-1990s when it was part of G.M., Hughes collaborated in the development of OnStar.

The emergence of Hughes Telematics is the first serious indication that the industry might be reawakening since Ford’s telematics entry, Wingcast, imploded in June 2002. Two years later, in March 2004, Wall Street showed little interest when telematics service provider ATX tried unsuccessfully to launch its IPO.

ATX and OnStar have been the only major telematics service providers in North America. Much, much bigger than any other telematics service provider in the world, OnStar says it has well over 4.5 million subscribers.

Hughes Telematics Inc. (HTI) believes it can change the business equation by providing an end-to-end solution that includes a national two-way digital communications network, telematics service center and its own in-house designed and developed embedded equipment platform.

“Hughes Telematics’ embedded equipment platform, ATX platform—the platform— including a fairly powerful ARM processor, quite a bit of memory, GPS, a communications module, CAN interface to vehicle buses, and possibly a Linux operating system—will set a new pricing standard,” Mr. G. Goldman indicated that the embedded platform could cost less than $100 to OEMs, especially if it is employed as a standard feature across all the OEM’s vehicle lines.

HTI aims to make its margins on the telematics services it provides and plans to charge as little as possible for the embedded equipment. In contrast, the embedded platform ATX uses in Mercedes vehicles is produced by Continental, so the supplier’s margin must be included in the hardware price. (Continental also will supply the hardware for the recently announced Ford Sync mobile device platform Ford developed with Microsoft.)

Hughes Telematics had hoped to be able to announce its deal with Chrysler in time to make a big splash at the Los Angeles Auto Show, but the carmaker did not give it the green light until January 5, just in time for the North American International Auto Show in Detroit. Chrysler has not yet announced which models will first be equipped with the telematics platform or when the service will be available.

Initially Hughes Telematics will provide voice and data communications via a digital cell phone network to supply basic emergency services like crash notification, roadside assistance and stolen vehicle tracking. That capability would be supplemented in the first year by a data downlink, provided by either XM Satellite Radio or Sirius Satellite Radio, so the OEM or a dealer could broadcast to all or
turn to Hughes, page 3
German Carmakers Agree to XML Standard for HMI

A meeting this past November at DaimlerChrysler facilities in Stuttgart, Germany, Volkswagen, Audi, BMW, DaimlerChrysler and Porsche engineers agreed to accept version 1.0 of a new standard they've been developing, which will use XML, the extensible markup language used on the worldwide web, to specify the HMI (human machine interface) requirements of audio and navigation systems. Further, the standard will also facilitate automatic testing of HMI code.

Volkswagen expects to be able to release its first RFQ based on version 1.0 by the end of 2007. Volkswagen already has some audio projects underway that use this XML process but not version 1.0 that the group has developed.

"The benefit of this standard is that every OEM will have the same interface to its tier one," declared Alf Pollex, who is responsible for HMI concepts, development and testing for the Volkswagen Group. "The HMI framework of a radio built at Blaupunkt or Visteon will be nearly the same regardless of whether it is for DaimlerChrysler, VW or Audi. That will lead to two important benefits. First, the cost for software development should go down. And second, the bigger benefit: If we have an automatic process for designing the HMI, creating this XML using tools, and then integrating the XML into the software using an automatic process, then we have the possibility to change HMI features very late in projects—by only changing the data, not the underlying software," said M. r. Pollex.

Thomas Fleischmann, a project manager at Elektrobit Automotive, pointed out another benefit, "With this approach, HMI development will become independent from application development, which will help the OEMs establish their brand-specific look and feel." Elektrobit Automotive, formerly 3SOFT, has experience working in an XML-based development process.

The next step in development of the standard is to move beyond the paper specification, which is difficult to understand because the XML description is very complex. Some time in January, the standards group intends to hire a company that will implement a use case based on the standard. That developer could be Elektrobit Automotive or IAV Gmbh, an automotive engineering firm that's a joint venture between Volkswagen (50%), Siemens VDO (20%) and others. Or one of the carmakers in the group could implement the use case.

Initially the HMI standard will be used to specify audio and navigation systems and eventually it could also be applied to the instrument cluster. But that will take a few years until clusters have enough memory and CPU power to handle the XML software layer.

Now that version 1.0 has been agreed to, the HMI standards group is open to taking input from engineers beyond Germany. "All of our results and our discussions are open to everybody," said M. r. Pollex. "It's all free. They can look at what we have done. If they want to change something they can make recommendations, which we will consider."

The specification is available in English. For more information please contact a.pollex@volkswagen.de.

Radar...

same chip, allowing designers to use a less expensive, garden variety DSP device. Lower cost radar sensors will help spur significantly higher volume production of advanced safety features such as side object detection and stop-and-go adaptive cruise control (ACC).

M/A-COM, a unit of Tyco Electronics, is likely to be among the world's leading suppliers of radar sensors. M/A-COM presently makes the 24 GHz short-range sensors (six per vehicle) in the Mercedes S-Class. It also supplies the 24 GHz short-range sensor used in BMW's stop-and-go ACC system, and will possibly supply the side-object detection sensor used on a future Chrysler vehicle.

In probably its biggest deal thus far, M/A-COM will supply short-range sensors to General Motors starting in 2009. M/A-COM will likely make the transition from GaAs to SiGe in production shipments starting in 2008 possibly using chips from Atmel Corporation, a silicon foundry with headquarters in San Jose, California.

A third radar sensors trickle down from the luxury-car segment to less expensive vehicles. M/A-COM, which also makes a RF module used in 77 GHz narrow band long-range sensors for ACC applications, could be producing as many as several hundred thousand short-range and 30,000 or more long-range sensors annually by 2011.

A ready producing discrete SiGe devices used in mobile phones, Infineon Technologies has five automotive development projects underway for SiGe radar transmitter-receiver chip sets. Testing is in process for prototypes that are heading toward qualification. Three of Infineon's five tier-one development partners are from Europe; one is from Japan and one is based in the United States.

A supplier of SiGe devices primarily for use in cell phones, Freescale says it is also working on a number of development contracts with third- or fourth-generation SiGe implementations aimed at automo-
Hughes...

multicast to a subset of the vehicles in the fleet.

Integrated Satellite-Cellular Communications Network

But in a step that the company thinks will distinguish HTI from OnStar and ATX, by year two or three after job-one, HTI intends to provide two-way satellite communications from Mobile Satellite Ventures (MSV). The Federal Communications Commission has granted MSV the first ever license to deploy and operate a satellite/terrestrial hybrid network that will provide high-speed, two-way voice and data communications ubiquitously throughout North America. The terrestrial component will provide coverage throughout major urban areas that suffer blockage from buildings, while the satellite component provides coverage in rural areas.

"About a year ago MSV issued a contract to Boeing to build two satellites that will launch in the 2009 timeframe," said M. R. Goldman. He continued: "These satellites are the most powerful satellites that have ever been launched for use by consumers. You'll be able to talk to this satellite with a cell phone that is no different in terms of size, weight, battery power or antenna size than the cell phone you carry today. We can add this communications capability to our telematics platform for only $5 or $10, and you'll never be out of coverage whether you're in Idaho or New York City."

MSV is controlled by SkyTerra Communications, a publicly traded company whose majority owner is Apollo Management. Mr. Goldman was a vice president at SkyTerra before joining HTI.

The Case for Telematics

The business case for Hughes Telematics rides in part on the assumption that OnStar is a positive contributor to GM. "GM's decision to put OnStar on every vehicle by the end of 2007 is telling in this environment of intense financial scrutiny, particularly when you consider the cost of putting the platform on low-end vehicles whose owners are the least likely to become paying subscribers," explained M. R. Goldman. "OnStar bases their business case on more than just subscriber revenue. They've convinced themselves that the data they're collecting from the vehicle has significant value. That's one of the side benefits of being standard in every single vehicle," he said.

Along with collecting diagnostic data, M. R. Goldman also sees tremendous value in traffic data: "In the middle of next decade, if we stay on plan, we'll have 10 million or more traffic probes running all over the U.S., on every road in America. That kind of traffic data will give us a killer application. HTI has developed intellectual property that collects traffic data based on exception reporting, to minimize the demands on the communications system.

A nother source of revenue will come from the insurance industry, which would use data from the telematics terminal to bill policyholders according to actual risk—determined by how and where they drive. "I'm under nondisclosure, but there are insurance companies who have done extensive research into this. By the turn of the decade they will have millions of customers operating under real-time insurance plans," said M. R. Goldman.

Networkcar

Networkcar is a wholly-owned subsidiary of Hughes Telematics Inc. Common Parent: Apollo Management

Apollo Management is a major owner of SkyTerra Communications, a publicly traded company. Sky Terra is the majority owner of Mobile Satellite Ventures. Apollo is a majority owner in Hughes Communications, also publicly traded. Hughes Communications owns 100% of Hughes Network Systems, service provider to Hughes Telematics Inc. Hughes Telematics Inc. is a private company, majority-owned by Apollo Management.

Networkcar is a positive contributor to GM. "GM's decision to put OnStar on every vehicle by the end of 2007 is telling in this environment of intense financial scrutiny, particularly when you consider the cost of putting the platform on low-end vehicles whose owners are the least likely to become paying subscribers," explained M. R. Goldman.

Radar

Continued from page 2

tive radar using BiCMOS (bipolar complementary metal oxide semiconductor) processes. By mid-2007 Freescale aims to make public its intentions to serve the automotive market with SiGe radar components. While he did not indicate whether or not IBM is currently working on SiGe devices for radar sensors, Bernie Meyerson, chief technologist of IBM's systems and technology group, said that since "IBM invented the technology more than ten years ago," deployment into the automotive market would require no new research. "This is something that you could start work on immediately and it would potentially take a couple of years to develop, certainly less than five years," he said.

Those interested in learning more about IBM's SiGe solutions should contact Tom Reeves, vice president for OEM technology, at 802-769-3977 or email treeves@us.ibm.com.

Too Many Frequencies

With or without SiGe, radar sensors could be a lot cheaper if the world could pick just one frequency. Europeans have clearance to use short-range 24 GHz sensors, but that's limited to no more than 10% of the vehicles in operation and only until 2013, after which they must switch cut the vehicles in operation and only until 2013, after which they must switch to 79 GHz for the short range. In Japan, 24 GHz is in use, but according to Niket Jindel, in charge of strategy and business development for Freescale's transportation equipment...
The Company Profile... NEC Electronics

Background

NEC Corporation spun off most of its semiconductor business—excluding DRAMs—in November 2002, forming NEC Electronics Corporation as a wholly-owned subsidiary. Following an IPO in July 2003, NEC Corporation’s ownership was reduced to 70%. NEC Electronics is listed on the First Section of the Tokyo Stock Exchange. NEC Electronics’ goal is to become the world’s number-one supplier of automotive microcontrollers, regardless of bit size, by the fiscal year ending March 2011.

Automotive Business

One of the most impressive things about NEC’s automotive business is who the top-ranking customers are: Toyota is number one and Toyota affiliate Denso is number two. In this industry, if you can serve Toyota, you can make a compelling case that you can serve the world. A ready the world’s number-one supplier of 32-bit microcontrollers in all markets, NEC Electronics’ goal is to become the world’s number-one supplier of automotive microcontrollers, regardless of bit size, by the fiscal year ending March 2011. NEC expects to be able to grow its automotive MCU business by 10.5% annually, to overtake Renesas Technology, currently the number-two supplier, and Freescale Semiconductor, currently the market leader. In five years, NEC says it will have a 20% share of the market for automotive MCUs, equal to ¥140 billion ($1.2 billion) in sales.

When it comes to all automotive semiconductors, NEC Electronics is the sixth-largest supplier in terms of sales, behind Freescale, Infineon, STMicroelectronics, Renesas and NXP, in that order. A automotive applications generate 55% of NEC’s microcontroller revenues today.

NEC serves its automotive customers from three automotive headquarters facilities around the world: in Kawasaki, Japan, Düsseldorf, Germany, and Irving, Texas, near Dallas. NEC’s efforts to develop its automotive market beyond Japan began nearly 12 years ago when the automotive industry first began to employ 32-bit microcontrollers, which NEC offers an extensive variety of power MOSFETs well-suited to automotive applications.

The company has been serving the automotive industry for 20 years. Sales in the Automotive and Industrial segment for 20 years. Sales in automotive applications.

FY 2006 Automotive Sales: ¥130 billion ($1.1 billion), roughly

Top Automotive Customers: #1 Toyota, #2 Denso

Automotive Employees: about 850, not including those who work in production

Automotive Products: 8- and 32-bit microcontrollers

Note: Fiscal Year 2006 ended March 31, 2006.

The Hansen Report on Automotive Electronics, Portsmouth, NH USA  www.hansenreport.com

Page 4, December 2006/January 2007
The Company Profile Continued

**NEC Electronics Automotive MCU Sales**

<table>
<thead>
<tr>
<th>Region</th>
<th>Application</th>
<th>2005</th>
<th>2006</th>
</tr>
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<td>Japan</td>
<td>Car multimedia</td>
<td>9.8</td>
<td>9.1</td>
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<tr>
<td></td>
<td>Powertrain</td>
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<td>17.8</td>
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<td>6.9</td>
</tr>
<tr>
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<td>Powertrain</td>
<td>0.5</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>Body</td>
<td>3.5</td>
<td>5.8</td>
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<tr>
<td>Europe</td>
<td>Car multimedia</td>
<td>6.8</td>
<td>6.6</td>
</tr>
<tr>
<td></td>
<td>Powertrain</td>
<td>3.4</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td>Body</td>
<td>14.2</td>
<td>18.0</td>
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<td>Asia</td>
<td>Car multimedia</td>
<td>8.8</td>
<td>7.4</td>
</tr>
<tr>
<td></td>
<td>Powertrain</td>
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<td>0.1</td>
</tr>
<tr>
<td></td>
<td>Body</td>
<td>2.4</td>
<td>3.0</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>83.9</td>
<td>90.1</td>
</tr>
</tbody>
</table>

NEC began marketing its products to the automotive industry in 2000. NEC Electronics America is positions to take advantage of those relationships as many of those suppliers, such as Autoliv, Siemens VDO, and Bosch, gain market share in North America. Within the next four years, these three customers will be among NEC Electronics America’s top six. In addition to Bosch and Siemens VDO, the company is currently working with Continental and Hella.

NEC began marketing its products to the automotive industry in 2000. The company serves the U.S. auto industry from engineering offices at its automotive headquarters in Irving, Texas, as well from engineering offices in Livonia, Michigan; Kokomo, Indiana; and Huntsville, Alabama. NEC Electronics America is positioned to take advantage of those relationships as many of those suppliers, such as Autoliv, Siemens VDO, and Bosch, gain market share in North America. Within the next four years, these three customers will be among NEC Electronics America’s top six. In addition to Bosch and Siemens VDO, the company is currently working with Continental and Hella.

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our goal," he said. In support of its zero-
failure strategy, the company eliminates
early failures by burning in at the factory
100% of the microcontrollers it produces.

NEC has two main microcontroller
product lines: the 78K0, built on an 8-bit
CISC (complex instruction set comput-
ing) architecture, and the V850, built on
a 32-bit RISC (reduced instruction set
computing) architecture.

Much of the company's success in the
automotive market is a result of its appli-
cation-specific family of products based on
a single microcontroller core: the V850,
first introduced in 1994. NEC has de-
veloped several product families that line up
nicely with particular applications, for
example the F Series is well suited to body
electronics; the S Series is well suited to
car audio; the D Series to dashboard appli-
cations, and the R Series to airbag appli-
cations.

Other families based on the V850 are
well suited to chassis and gateway applica-
tions. These products are primarily used in
Europe today and are expected to be in-
troduced in North America in the future
as these markets develop.

By staying within a particular series or
family, engineers can develop a line of
applications ranging from low- to high-
end in terms of memory size, performance
and number of I/Os, while maintaining
the same architecture and reusing a lot of
the software that's common throughout
the product line.

Another aspect of the family concept is
that the 32-bit core microcontroller can
economically be applied to applications
usually served by 16-bit devices. Until
February 2006, when it introduced its new
78K0R line of 16-bit flash MCUs, NEC
was unique in the marketplace in that it
didn't have a 16-bit product.

Mr. Trent elaborated: "So in body ap-
lications, for instance, as customers who
had been developing with 8-bit devices
evaluated their future they wondered,
'Should we go to a 16-bit device for two
or three years and then jump up to a 32-
bite processor?' Or, should we skip over
the 16-bit CISC product line and go directly
to a cost-competitive 32-bit RISC pro-
cessor, that can expand from 128K of flash
memory all the way up to two M B, where

we can use the same peripherals (timer, A/
D, or serial peripheral interface), the same
tools, the same bus structure and develop
it for a long period of time using much of
the same code?"

Large flash memories are needed as en-
gineers rely increasingly on software to
differentiate their products. NEC's MCUs
employ SuperFlash™ technology licensed from Silicon Storage Technology.

NEC Electronics is constantly looking at
the V850 microcontroller core to make
sure that it continues to meet automotive
requirements for performance and
memory. The company has no plans at
this point to expand its product line be-
yond the V850 family.

Six working teams meet three times a
year to develop global product strategies
for each family of application-specific
microcontrollers: audio, powertrain, chas-
sis, dashboard, body and safety. "Their job
is to develop product roadmaps that com-
prehend future requirements for memory
size, for flash-to-memory ratio, and net-
work connectivity, whether it's LIN, CAN
or FlexRay, or in which devices to imple-
ment AUTOSAR requirements," ex-
plained Mr. Trent. NEC is an active
contributor to the European group devel-
oping the AUTOSAR standard.

The only player in the Japanese auto-
motive semiconductor market larger than
NEC is Renesas, a company created by
the merger in April 2003 of Hitachi's and
Mitsubishi Electric's semiconductor divi-
sions. Aiming to "unite these two product lines,
but it looks like it still may take time to
do that."

While Renesas has managed through
its focus on navigation and infotainment
to become the world's leading player in
those markets with its SuperH, 32-bit
microcontroller architecture, NEC says it
is far ahead of Renesas in audio system
microcontroller applications.

Wireless USB

A ccording to NEC, an important trend
affecting automotive semiconductor design has been the
demand by consumers for increased con-
nectivity for portable devices such as the
iPod. That demand seems to be accelerat-
ing. While carmakers are already install-
ing wired USB connectors into vehicles to
link MP3 players with the vehicle's audio
system, they are also inquiring about wire-
less USB connectivity, even before the
market for consumer products with Wire-
less USB links reaches high volume.

With wireless USB, consumers could
come to download music or audio files
to their vehicles. In a demonstration at
the recent Convergence conference on
automotive electronics in Detroit, NEC
demonstrated downloading digital video entertainment
columns to a vehicle's on-board hard drive
through a wireless USB link. "It is a fea-
ture that would sell cars," said Mr. Trent.

Body

L ately, NEC's fastest-growing MCU
application is in body controllers, which
are general purpose machines that handle
an ever increasing number of features usu-
ally installed within the passenger cabin.
These include seat heaters, window lift
controls, door locks, heated exterior mir-
rors, memory seat modules, wiper controls,
keyless entry system, anti-theft mecha-
nisms and lighting controls.

Most of the excitement in body appli-
cations is about memory—the more the
better. NEC's MCUs designed for body ap-
lications typically serve body systems
such as the door control system, the
passenger airbag system, and the
"data bus" system that connects all the
controllers together.

Motor, body, and data bus applications
are all well served by NEC's 16-bit MCUs.

Automotive MCUs Worldwide Revenue

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>2005 Sales (millions)</th>
<th>Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freescale Semiconductor</td>
<td>1,256</td>
<td>25%</td>
</tr>
<tr>
<td>Renesas Technology</td>
<td>860</td>
<td>17%</td>
</tr>
<tr>
<td>NEC Electronics</td>
<td>627</td>
<td>12%</td>
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<tr>
<td>Fujitsu</td>
<td>369</td>
<td>7%</td>
</tr>
<tr>
<td>Texas Instruments</td>
<td>334</td>
<td>7%</td>
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<tr>
<td>Infineon Technologies</td>
<td>329</td>
<td>7%</td>
</tr>
<tr>
<td>Intel</td>
<td>235</td>
<td>5%</td>
</tr>
<tr>
<td>Toshiba</td>
<td>195</td>
<td>4%</td>
</tr>
<tr>
<td>Samsung Electronics</td>
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<td>4%</td>
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<tr>
<td>STMicroelectronics</td>
<td>138</td>
<td>3%</td>
</tr>
<tr>
<td>Microchip Technology</td>
<td>127</td>
<td>3%</td>
</tr>
<tr>
<td>Other</td>
<td>369</td>
<td>6%</td>
</tr>
</tbody>
</table>

Data: Gartner Dataquest

The Company Profile Continued

**Automotive Products**

### 8-bit 78K0 microcontrollers
- Industry-leading low-EMI technology
- Integrated peripherals with J1850, CAN and iEBus communications interfaces
- LIN bus support
- Flash memories from 8 KB to 128 KB
- Suitable for low- to mid-end audio systems, door modules, HVAC equipment, dashboard displays, low-end clusters and backup engine control systems

### 8-bit 78K0S microcontrollers
- Flash memories from 1 KB to 32 KB
- Suitable for remote keyless entry devices, center console displays, immobilizer systems, seat modules, wiper and alternator controls

### 32-bit 8V80 microcontrollers
- Scalable performance from 5 MIPS at 4 MHz to 260 MIPS at 200 MHz
- Wide range of peripherals, up to 6 CAN interfaces
- LIN bus support, up to 9 channels
- Flash memories from 64 KB to 2 MB
- Wide range of packages from a 64-pin QFP to BGAs with 240 or more pins
- Suitable for audio, body, telematics, mid-range to high-end instrumentation, low-end multimedia, electronic power steering, gateways, smart junction boxes, ABS, and engine control systems

### High-end microcontrollers
- Industry-leading technologies focusing on parallel processing and multi-threading
- Suitable for car computers, voice recognition systems, high-end audio systems and applications that require lower power consumption and very compact board design
- Ideal for next-generation applications ranging from video decoding for video over satellite systems to image processing for driver safety systems (for example lane tracking, obstacle detection, driver alertness monitors and night vision)

### Third-generation CAN interfaces
- FlexRay communications controller IP
- Power MOSFETs
  - On-resistance as low as 1.2 milliohms
  - Large portfolio handling currents up to 180 amps
- Intelligent power devices
  - Ideal for relay replacement, lamp, solenoid and injector drive applications
- Cost effective multichip packaging of control chip and power MOSFET
- RF semiconductor products
  - Including 24 GHz, GaAs short-range radar sensors

### IMPACAR Applications

- Lane tracking
- Pedestrian detection
- Object detection
- Drowsy driver detection

Taking input from camera sensors, the IMPACAR LSI processes video data in real time at the rate of 100 giga (billion) operations per second, which is equivalent to 30 frames per second. It manages this while operating at just 100 MHz, to limit power consumption to less than 2 watts, through parallel processing of 128, 8-bit processing elements that follow a single command using single-instruction, multiple data process instructions. Each processing element simultaneously executes 4 instruction sets per word. The IMPACAR LSI is built from 0.13-micron process technology.

**Potential Market for Automotive Image Recognition Systems**

<table>
<thead>
<tr>
<th>Year</th>
<th>NEC expects to win a 40% share</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>8.6</td>
</tr>
<tr>
<td>2012</td>
<td>18</td>
</tr>
<tr>
<td>2015</td>
<td>18</td>
</tr>
</tbody>
</table>

Source: NEC Electronics

**Powertrain**

Compared with other semiconductor makers serving the auto industry, NEC got a relatively late start in applying its microcontroller expertise to powertrain applications. Those efforts began in Japan in 1996 with the V853, which NEC says is the world's first 32-bit RISC microcontroller equipped with flash memory.

Today NEC ships nearly ¥18 billion ($153 million) worth of microcontrollers to Japanese customers for powertrain applications, which accounts for the vast majority of the company’s worldwide powertrain MCU sales.

But success in Japanese powertrain applications hasn’t yet translated to NEC’s customers in Europe or the U.S., where the company’s powertrain applications have been almost nonexistent. “What we have done in Japan doesn’t match what our customers in the U.S. and Germany expect from a powertrain MCU,” said Mr. Trent. “For future U.S. requirements, more functionality will be done in software, for example modeling virtual sensors. The timers will be more complex, and more DSP functionality with faster data conversion will be needed. Memory requirements are also growing, up to six megabytes.” In contrast, Japanese customers are more inclined to use mixed signal products and to be more conservative about applying new technology to maintain the utmost in quality.

**Image Processor**

A key component in the very hot market for active safety is NEC’s IMPACAR (image memory array processor for car), an exceptionally fast image processing LSI used for the first time in the new Lexus LS 460. Developed with Toyota and Denso, the device is used to enable detection of vehicles, pedestrians and lane markings. The Lexus LS 460 employs some of the world’s most advanced active safety systems including brakes that are automatically actuated to avoid crashes.

While there is a great deal of interest in IMPACAR from several OEMs and tier-one suppliers looking at pre-crash sensing and pedestrian sensing, along with other active safety applications, NEC Electronics has had to limit its commitment to development projects to only a few, so far. The company wants to be careful not to overwhelm its internal support team. NEC has only recently begun talking seriously to customers outside of Japan about IMPACAR. Despite its disciplined roll out of the technology, by March 2007 NEC expects to have won a 40% share of a ¥50 billion ($42 million), global market for automotive image recognition LSIs.

The Telematics and Navigation Markets According to TRG

Last month we were privileged to get an update on the state of the telematics, navigation and other markets from one of the world’s foremost experts, Dr. Egil Juliussen, cofounder and principal analyst of the Telematics Research Group (Minnetonka, Minnesota).

Dr. Juliussen is very optimistic about the telematics market and believes that because of GM’s success with OnStar and because of the long-term potential of telematics, other carmakers will soon start deploying telematics products. TRG defines telematics as applications that are based on information flowing from or to the car via wireless communications.

A study by a group of experts, TRG maintains a database that tracks the number of cars sold, the number of cars equipped with telematics options, and other information such as the number of subscribers, the number of features offered, and the number of vehicles equipped with each feature.

According to TRG, portable navigation is particularly hot today and will grow strongly, because it will be used for both car and pedestrian navigation. With the wide availability of low-cost portable navigation devices, Dr. Juliussen expects the average price of in-vehicle navigation to decline significantly—to below $1,000 in five or six years, and down to approximately $500 in 10 years.

Worldwide Navigation Market by Year and Type

<table>
<thead>
<tr>
<th></th>
<th>2006</th>
<th>2011</th>
<th>CAGR</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-vehicle navigation</td>
<td>10,216</td>
<td>16,955</td>
<td>10.7%</td>
</tr>
<tr>
<td>Portable navigation devices</td>
<td>11,174</td>
<td>24,401</td>
<td>16.9%</td>
</tr>
<tr>
<td>Smartphone/PDA w/navigation</td>
<td>6,053</td>
<td>30,496</td>
<td>38.2%</td>
</tr>
<tr>
<td>Cell phones w/ off-board navigation</td>
<td>4,858</td>
<td>73,476</td>
<td>72.2%</td>
</tr>
<tr>
<td>Total portable navigation</td>
<td>22,085</td>
<td>128,373</td>
<td>42.2%</td>
</tr>
<tr>
<td>In-vehicle + portable navigation</td>
<td>32,301</td>
<td>145,328</td>
<td>35.1%</td>
</tr>
</tbody>
</table>

Data: Telematics Research Group

According to TRG, portable navigation is particularly hot today and will grow strongly, because it will be used for both car and pedestrian navigation. With the wide availability of low-cost portable navigation devices, Dr. Juliussen expects the average price of in-vehicle navigation to decline significantly—to below $1,000 in five or six years, and down to approximately $500 in 10 years.

The numbers of cars sold, the number of cars equipped with telematics options, and other information such as the number of subscribers, the number of features offered, and the number of vehicles equipped with each feature.

Worldwide, the number of embedded telematics platforms sold each year to support OEM monitored telematics solutions like OnStar’s is expected to grow from slightly more than four million units in 2006, to 13 million units by 2011.

What features and benefits will drive telematics growth? Dr. Juliussen sees two main beneficiaries of telematics: the carmaker, who benefits the most, by far, and the customer. “In the long term what the carmaker gets out of telematics literally will pay for itself several times over.” For example, a remote diagnostics link to every electronic control unit will provide carmakers with an “information goldmine” that will be used to improve reliability and limit warranty costs, among other things. Eventually, carmakers will use telematics to remotely update the vehicle’s software. “I compare it to the PC industry; Windows XP sends new updates all the time because they keep finding things to fix or improve,” he said. “With the increasing penetration of driver assist systems, we are adding more and more ECUs. You have to manage those, and telematics is going to be the tool that allows you to do that.” By 2020, TRG expects that all of the world’s autos will be capable of remote diagnostics and remote software updates.

As for consumers, Dr. Juliussen believes their interest in navigation and traffic information services as well as entertainment and other information content will drive their demand for telematics. By year-end 2006 some 100,000 subscribers were taking advantage of OnStar’s turn-by-turn navigation feature, according to Dr. Juliussen. By 2011, there will be 3.5 million OnStar users of turn-by-turn navigation.

Founded in 2000, now with 15 employees, TRG maintains a database that tracks 32 features offered on 2,900 different car models in 20 countries. Subscribers get access to that data base. To learn more about the Telematics Research Group’s products and services, please visit www.telematicsresearch.com.