Edited by **Kevin Jost**

Regs, electronics drive chip development

Big businesses are not generally seen as big fans of government regulations. But automotive legislation for emission controls and the recent electronic stability control mandate typically mean market growth for chip suppliers.

"I can't recall a regulation that had a negative impact for us," said Paul Grimme, General Manager of **Freescale Semiconductor**'s Transportation and Standard Products Group.

Regulations are currently helping drive semiconductor growth in powertrains and safety that are two of the hot growth areas for 32-bit CPUs, which are themselves the fastest-growing segment in electronics, Grimme noted.

Freescale, now privately held after being acquired by **Blackstone Partners** two years after spinning off from **Motorola**, was the top automotive chip vendor in 2006, according to **Strategy Analytics**. Automotive revenues of about $1.95 billion—about a third of the firm's $6.4 billion revenues—gave it an 11.2% market share, by Strategy Analytics' count.

Software challenges

While regulations help, there is little concern that automotive designers would forget about chips without legislative mandates. The real concern is how to make the best use of the many chips in a vehicle. Vehicle and system engineers are constantly striving to make tradeoffs between integrating functions into a single, powerful controller and distributing less expensive, embedded chips close to the units they control.

"The proliferation of nodes and microcontroller-based systems is starting to create chaos as vehicle makers try to get their hands around the number of nodes and all the capabilities these systems have," Grimme said.

At this point, there is a trend to utilize the power of 32-bit chips to bring functions into electronic control units. "High-performance microcontrollers can do the work of several nodes, so we're seeing more and more 32-bit CPUs combining systems that were independent in the past. But they often have sub-nodes around them," Grimme said.

Freescale is addressing this challenge in part with a recent partnership with **STMicroelectronics**. The two will jointly develop 32-bit PowerPC cores, flash memory, and other technologies.

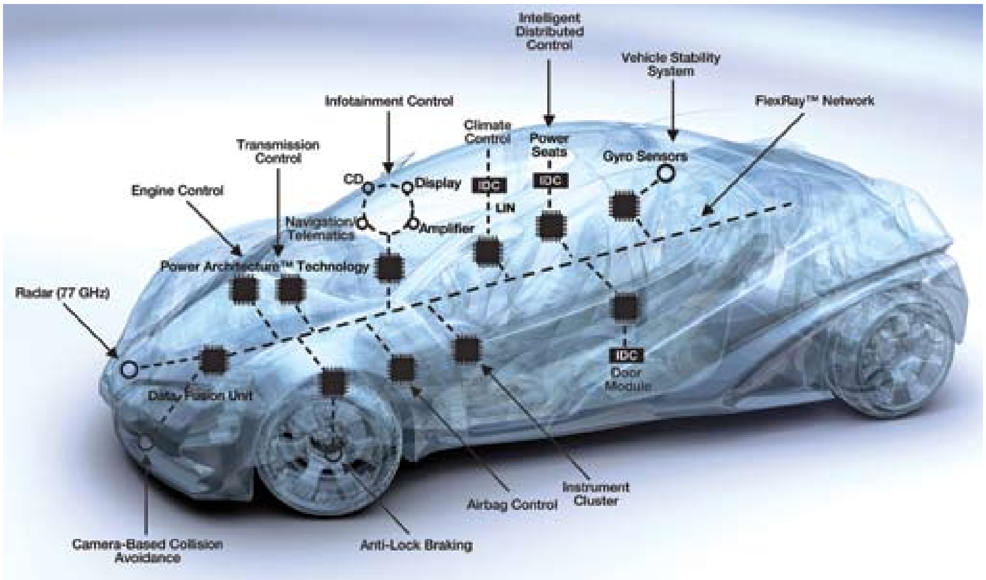
This linkup boosts their collective R&D spending, but should also benefit automotive software developers who will have fewer design tools to learn and more chance to reuse code. "As 32-bit processors increase the need for software, companies can't afford to do more from scratch," Grimme said. "They want standardization. The smaller the number of microprocessors they have, the easier it is for them to standardize."

That may sound a bit like the approach taken by members of the ARM consortium, who promote the commonality of CPU (central processing unit) cores as a way for customers to reduce the number of architectures they use. But Grimme noted that cores alone are not the biggest part of the programming challenge, adding that each ARM supplier has different processes and peripherals.

"Cores are important for standardization, but there are differences like flash memory, which changes every time you go from one process to another," Grimme said. "Between memory and the peripherals on the chip, the software for the core is really a small amount of the total. That's why our alliance with ST uses the same core, peripherals, and flash."

In the future, CPU cores will follow the lead of the fast-moving personal computer market, where dual-core processors have taken over, offering speed improvements without significant increases in power consumption. That is attractive to automakers because power means heat, which can impact lifetimes, as well as saving for power systems strapped by the rise of electronic systems.

Partnerships, regulations, and globalization are helping Freescale's Grimme as he tries to maintain his company's top spot in automotive semiconductors.



Freescale chips are used throughout vehicles.

They also play into the push for safety. "Multi cores add performance, but they also have redundancy that you want for safety systems," Grimme said.

Risks and rewards

Another major challenge is the rapid emergence of the Chinese market. Freescale has many operations there, with more than 1500 employees helping the company gain share in the nascent market. Though many Chinese vehicles are entry-level products, they offer solid opportunities for chipmakers.

"Production in China is not low-end, simple products," Grimme said. "One of the largest-selling vehicles in China is a fairly high-feature vehicle made by GM, and even some of the smallest vehicles made by Cherry have some sophisticated electronics."

Though China holds sizable potential, doing business there is not without significant risk. China's intellectual property protection is lax, so preventing copyright theft is difficult.

Freescale's technology was at the heart of a prime example least year. A professor at highly regarded Jiaotong University claimed to have developed a powerful DSP (digital signal processing) chip, but he was later fired for merely copying Freescale technology.

Grimme does not see theft as a huge issue that will prevent Freescale from gaining market share. "There's a very large leap between taking that IC and creating it in volumes that automakers need," Grimme said.

Freescale is also making a big push to grow its market presence in the Japanese automotive market. The two countries pose dramatically different challenges.

"In Japan, we've got a very formidable set of competitors and a well-established supply chain so it becomes a technical discussion," Grimme said. "In China, it's a much different story around rapid development with lots of opportunities."

Private equity

The business side of technology extends beyond dealing with customers. Freescale's acquisition by private-equity giant Blackstone is evidence of a trend in automotive ownership. **Lear**, Freescale's competitor/partner **NXP Semiconductors**, and now **Chrysler** have also turned to private equity, and **Siemens VDO** has been mentioned as a private-equity target.

While that marks a big change, it is not one that Grimme feels will have much of an impact. "We're watching an important chapter in many industries as sources of funding like private equity come in," he said. "I don't see anything that's not a normal response of maturing industries. Private equity in just one player," he said.

Going private provides both benefits and a hint of uncertainty, he explained. On the upside, deep pockets make it more likely that Freescale can expand its portfolio with an acquisition or two. But looking forward, there's always the possibility that Blackstone will see a chance to profit by selling the chipmaker, Grimme said.

Terry Costlow

Let the autonomous driving games begin

The 2007 Defense Advanced Research Projects Agency (**DARPA**) challenge calls for driving 60 mi (96 km) in less than six hours. That seems like a simple enough task, but this competition's twist is that only self-driving vehicles are in the hunt for the $2 million grand prize. The autonomous ground vehicles competing in the 2007 DARPA event will take to the streets this November in a yet-to-be-named urban locale in the western United States.

"The DARPA challenge of old was wild desert driving, which meant not dealing with all the rules of the road" said William Whittaker, Director of the Field Robotics Center at **Carnegie Mellon University** (CMU) and the leader of the university's Tartan Racing team composed of faculty, students, and staff.

No teams finished the first DARPA challenge in 2004 within the allotted time. That race among 15 vehicles covered a 142-mi (229-km) patch of the Mojave Desert. "But Carnegie Mellon went the farthest of any team, and we went the fastest as well," said Chris Urmson, Director of Technology for Tartan Racing. The team finished in second and third places in the 2005 DARPA event, a desert trek of 132 mi (212 km).

New rules prohibit any team from having multiple vehicles in this year's competition, but the Tartan team has prepped two 2007 **Chevrolet** Tahoe SUVs. "Both vehicles are operational, so it allows us to speed up testing and it gives us a 'spare' should something happen during qualifications," said Urmson.

Tartan Racing's robot-SUVs feature the latest technologies. "Being a team member is a great way to keep our finger on the pulse of mobile robotics," said Michael Taylor, an embedded research engineer with **Caterpillar**, one of many Tartan Racing sponsors. "This is 'bleeding-edge' technology, meaning this is absolutely state-of-the-art."

Radar, lidar, and cameras give the Tartan vehicle its field of vision. The team is "experimenting with a lidar sensor from **Velodyne** that provides a large field of view—approximately 25 degrees by 360 degrees," said Urmson. Beyond the sensors used on the production Tahoe, each SUV has an additional 25 perception sensors.

Jason Ziglar, a Carnegie Mellon robotics graduate student, is involved in developing the software that enables a Tartan Racing vehicle to navigate the streets. "The real challenge is just the robustness of the perception/sensing system because the vehicle needs to handle any situation, ranging from detecting lane markings and curbs to recognizing the shape of the road," said Ziglar.

KAMI BUCHHOLZ

Carnegie Mellon University's Tartan Racing is prepping a 2007 Chevrolet Tahoe for the 2007 DARPA Urban Challenge.

Chris Urmson, Director of Technology for Tartan Racing, shows the computers and electronics that are embedded in the Tartan Racing vehicle. The rear cargo area also includes a safety system that allows the vehicle to be stopped via a radio signal, if needed.

Tartan Racing's SUV Specs	
Base vehicle	2007 Chevrolet Tahoe
Powertrain	5.3-L V8, 4L60 automatic transmission, 4WD, E85 fuel
Drive-by-wire	GM engine control, EMC Aevit electronic steering, Continental brake-by-wire
Maximum autonomous speed	30 mph (48 km/h)
Short-range radar	8 M/A-COM wide-field-of-vision radar modules
Long-range radar	5 Continental ARS300
Short-range lidar	8 Sick LMS-291
Mid-range lidar	Velodyne HDL-64
Long-range lidar	2 steered Continental ISF 172 and 2 Ibeo ALASCA XT
Forward-looking road detection	Mobileye ACP 5
Pose estimation	Applanix mPOS-LV with dual antenna GPS and IMU
Computing	10 Intel Core2Duo blades at 2.16 GHz in a compact PCI chassis
Onboard storage	2-GB NetApp data-storage appliance
Auxiliary power	8-kW Aura Systems Auragen belt-driven, underhood generator
Software architecture	Decentralized, multi-process system coordinated via gigabit Ethernet communications layer
Planning	Motion planning evaluates more than 1000 candidate trajectories per second
Perception	Multi-sensor fusion generates moving and static obstacle models
Behavioral	Context-centric reasoning makes tactical decisions
Software complexity	More than 250,000 lines of code

An array of computers and other electronics have been fitted inside the Tahoe's cabin.


KAMI BUCHHOLZ

Michael Darms, a Project Engineer with **Continental**'s Driver Assistance Systems Engineering, is working with the Tartan team full-time as an embedded engineer. "This project is fun and exciting, and it gives me opportunities to apply my theoretical and practical knowledge," he said.

One contribution from Darms is a practical application of his Ph.D. thesis topic—sensor data fusion—for Germany's **Darmstadt University of Technology**. The software architecture "generates a world model, which is sort of a picture describing the vehicle's surroundings so that the Tartan Team's Tahoe can accomplish its missions, which means going from point A to point B, completing a task—like parking or making a U-turn—at point B, and then going on to point C, and so on," said Darms.

Tartan Racing Team Sponsor Highlights	
Applanix	Ibeo
Caterpillar	Intel
CleanPower Resources	M/A-COM
Continental Automotive Systems	Mechanical Simulation
General Motors	Mobileye
Google	NetApp
Hewlett Packard	TeleAtlas
	Vector CANtech

General Motors developed and provided vehicle-control and sensor-fusion logic "that fuses key active-safety sensors—similar to the ones used on GM vehicles today—including the long-range and short-range radars and vision cameras for lane detection and object classification," said Varsha Sadekar, a Group Manager with the Active Safety and Driver Assistance Group at GM's Warren, MI, R&D center.

For the DARPA challenge, the Tahoe's transmission and engine controllers were modified to support an auxiliary generator and increase overall vehicle performance. Sensors are used to detect steering- and road-wheel angle, and at present the Tartan Tahoe's steering, throttle, and brakes are all electromechanically controlled. "This provides redundant, safe, and proven override capability while the vehicle is being tested with test engineers and passengers on board," noted Sadekar.

Long- and short-range radars/lidars, cameras, vehicle-positioning solutions, and by-wire actuators as well as other technologies employed on the Tartan Racing vehicles will play a role in GM's near-future programs. "We are getting significant hands-on experience with these technologies that will get transferred to our products, including advanced algorithm development, sensor characterization, testing and evaluation procedure development and execution, and endurance testing of components and systems," Sadekar said.

Teams qualify for the DARPA Urban Challenge in October. The November 3 competition's top three finishers that complete the course within the time limit receive \$2 million, \$1 million, and \$500,000, respectively. DARPA is the central research and development organization for the **U.S. Department of Defense**.

Kami Buchholz