The idea of using the windshield to project information into the driver’s field of view has been around at least since the late 1980s when Delphi tried to transfer head-up display technology from fighter aircraft to the automobile. Twenty years later the automotive HUD market began to organize, but by 2008 was only at 100,000 units globally. In the seven years since then, the market has finally gained some traction. According to Strategy Analytics, it will reach 2.2 million units in 2015 (2.5% penetration), a 56% CAGR. By 2020, 7% of new vehicles will come equipped with HUDs, bringing the total market to 7.9 million units.

“Today 10 different OEMs offer HUDs in about 19 different auto brands,” said Eelco Spoelder, executive vice president for Continental’s instrumentation and driver HMI business unit. “Based on the RFQs we have seen, we anticipate that by 2018, 17 OEMs will offer head-up display on 33 brands. ... Continental has been producing color HUDs since 2003.”

Today, HUDs from Continental range in retail price from about 150 euros for combiner HUDs, up to several hundred euros for HUDs that project off the windshield.

Windshields that are part of the HUD system are designed especially for that purpose. “A normal windshield has a flat vinyl layer to provide shatter protection in crashes,” explained Joe Pullukat, a senior manager for engineering at HUD pioneer, Nippon Seiki. “Windshields used with head-up displays get a special wedgeshaped vinyl layer to eliminate the double image or ghosting that would occur without it.” A further complication is that every HUD is different due to the way the windshield is modified.

Instead of making the windshield part of the HUD, combiner HUDs project a virtual image on the windshield. A normal windshield has a flat vinyl layer to provide shatter protection in crashes, said Pullukat. “Windshields used with head-up displays get a special wedgeshaped vinyl layer to eliminate the double image or ghosting that would occur without it.” A further complication is that every HUD is different due to the way the windshield is modified.

Genivi is setting up a security team to address issues related to infotainment software. Fabien Hernandez, infotainment software architect at PSA, is the team leader. “The first thing we should work on is the threat model, a list of possible attacks and countermeasures. We need to understand what must be included inside Genivi middleware. Essentially we are defining security requirements.” Security experts from carmakers and suppliers interested in contributing to the Genivi security team are invited to email Mr. Hernandez at fabien.hernandez@mpsa.com.
Companies—Harman, Green Hills Software and Autoimmune—are described below.

Harman’s 5+1 Security Model
I.P. Park, CTO of Harman, described the 5+1 Security Model the company demonstrated in early June at TU-Automotive Detroit. "From the point of view of the head unit ... it is a comprehensive, coordinated solution to make every level of the system secure."

"At the lowest level there is a secure hardware platform. The next layer up is a hypervisor that provides separation between multiple operating systems. Above that is the operating system level with hardened security in terms of access to peripherals and storage. Above that is application sandboxing that provides isolation between applications. And the last level is network protection, where there is firewalling between the head unit and the Internet, or the network connection between the head unit and the CAN bus. 'Plus 1' refers to the necessary ability to update the system over the air. Systems are becoming extremely complex. Our infotainment system probably has 20 million lines of code. If you count all the code in a high-end car, we are talking about 100 million lines of code. Software bugs are inevitable and the bugs cannot all be fixed right away."

Integrity Security Services, a Subsidiary of Green Hills Software
The security risk represented by hundreds of millions of Internet-connected cars has already attracted a multitude of potential competitors from outside the automotive industry. "Everybody from the enterprise space wants to get into this business," cautioned David Sequino, vice president and general manager of Green Hills’ Integrity Security Services (ISS) subsidiary. "These enterprise companies have a skewed sense of how to solve this problem. They say 'Just put a firewall or intrusion prevention box in.' But that’s a recipe for disaster. How could there be so many hacks [of businesses and government systems] when the firewall market has been going for 25 years?"

"Our firewall prevention system is different. This is an embedded issue that needs to be solved at the lowest levels by embedded experts. We work directly with multiple OEMs and tier-ones to work out the security of their supply chain. Our approach is to authenticate all known good software that comes from a known good source. We can inject digital identities into every ECU and then we maintain that identity to do things like over-the-air firmware updates securely. We can digitally sign every piece of firmware, every piece of software, every command or every piece of content coming from the backend data center to the vehicle. If we don’t sign it, it is not allowed to run. Our system is signing hundreds of millions of pieces of firmware that are going into vehicles."

ISS is the prime subcontractor to the Crash Avoidance Metrics Partnership (CAMP), for delivering a security credential management system to NHTSA, which is developing a proof of concept for V2V security. Ford, General Motors, Honda, Hyundai Motor, Daimler, Nissan, Toyota and Volkswagen are part of CAMP.

Green Hills Software is also a leading supplier of compact, real-time operating systems for infotainment, instrument clusters, driver assistance systems, safety systems and the powertrain. According to the company, its "Integrity RTOS technology is certified to the highest security level ever achieved for any software product: EAL6+ High Robustness." Another product, the Integrity Multivisor, provides secure separation between operating systems.

Autoimmune Inc.
Karl Heimer, founding partner of Autoimmune, has been working in cybersecurity for more than 20 years, first for the U.S. Army and later for government contractors Lockheed Martin and Sparta. Prior to Autoimmune he was senior research director at Battelle, in charge of the cybersecurity for cars business. Battelle recently exited that business.

A four-person consultancy, Autoimmune conducts vulnerability analysis, provides security consultation, and aids in the creation of cybersecurity products across the transportation value-chain. The company provides cybersecurity training for automotive customers and performs as a general contractor to help suppliers secure their embedded systems.

Mr. Heimer spoke to us recently about one of his security hot buttons. "Security is not composable. If module A is secure and module B is secure and you wire module A and B together, AB is not necessarily secure. You have to assess it again. Whereas, insecurity is composable. If you have insecure A and secure B, C, D and E and you wire it all together, then ABCDE is going to be insecure."

"What this means is you can’t simply bolt on a module to secure your car after the fact. You have to architect a secure solution and then make sure you populate it with secure components. That is a much harder problem."

"You can still create an architecture that incorporates safety as well as gives users individual freedom on how open they want to make certain parts of the car, allowing users to download applications and connect to things that have a risk for malware. You can be relaxed about parts of the car while heavily guarding the safety critical parts of the car."

Mr. Heimer expects to see some differentiated cybersecure cars out within two or three years. "Hackers who are looking for PII [personally identifiable information] will decide that those cars are too hard to hack and move on to easier ones."
Published earlier this spring, this comprehensive and intelligent 133-page report deserves a close look. Focused on the next 5 to 10 years, the report evaluates and explains how technology will shape tomorrow’s cars. The report looks at the trends with an eye on what effect they will have on some of the publicly traded tier-one and tier-two suppliers. The full report is available at www.citivelocity.com.

Below are two figures from the report.

### Market Growth of Major Applications and Products
(Estimated CAGR between 2013 and 2020)

<table>
<thead>
<tr>
<th>Category</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor having Li-ion Battery</td>
<td>10%</td>
<td>12%</td>
<td>15%</td>
<td>18%</td>
<td>20%</td>
<td>25%</td>
</tr>
<tr>
<td>Automotive Radar</td>
<td>8%</td>
<td>10%</td>
<td>12%</td>
<td>14%</td>
<td>16%</td>
<td>20%</td>
</tr>
<tr>
<td>Automotive Camera</td>
<td>5%</td>
<td>7%</td>
<td>9%</td>
<td>11%</td>
<td>13%</td>
<td>18%</td>
</tr>
<tr>
<td>Connector</td>
<td>7%</td>
<td>8%</td>
<td>10%</td>
<td>12%</td>
<td>14%</td>
<td>19%</td>
</tr>
<tr>
<td>ECU</td>
<td>4%</td>
<td>5%</td>
<td>7%</td>
<td>9%</td>
<td>11%</td>
<td>16%</td>
</tr>
</tbody>
</table>

### Review of Global Safety Regulation Events

<table>
<thead>
<tr>
<th>Year</th>
<th>Region</th>
<th>Outline</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>North America</td>
<td>US NCAP adds points for LDW and FCW</td>
</tr>
<tr>
<td>2013</td>
<td>Europe</td>
<td>LDP and AEB made compulsory for large vehicles</td>
</tr>
<tr>
<td>2014</td>
<td>Europe</td>
<td>ESC made compulsory for all new vehicles</td>
</tr>
<tr>
<td>2014</td>
<td>Europe</td>
<td>Euro NCAP adds points for LDW and AEB</td>
</tr>
<tr>
<td>2014</td>
<td>Japan, Korea, Europe</td>
<td>ESC made compulsory for all new vehicles</td>
</tr>
<tr>
<td>2014</td>
<td>Japan</td>
<td>LDP and AEB made compulsory for large vehicles</td>
</tr>
<tr>
<td>2014</td>
<td>Japan</td>
<td>Regulations accelerated installation of LDW and AEB in commercial vehicles</td>
</tr>
<tr>
<td>2015</td>
<td>North America</td>
<td>Camera installation could be made compulsory</td>
</tr>
<tr>
<td>2015</td>
<td>Europe</td>
<td>Euro NCAP modifies side camera ISO regulations</td>
</tr>
<tr>
<td>2016</td>
<td>Europe</td>
<td>Euro NCAP adds points for pedestrian detection and AEB</td>
</tr>
<tr>
<td>2016</td>
<td>Japan</td>
<td>Japan could approve side mirror cameras</td>
</tr>
<tr>
<td>2017</td>
<td>North America</td>
<td>North America approves side mirror cameras</td>
</tr>
<tr>
<td>2017</td>
<td>North America</td>
<td>US NCAP adds points for PD and AEB</td>
</tr>
<tr>
<td>2018</td>
<td>Japan</td>
<td>Japan could approve the use of autonomous parking assist</td>
</tr>
<tr>
<td>2018</td>
<td>Europe</td>
<td>Euro NCAP adds points for night use PD and AEB</td>
</tr>
<tr>
<td>2018</td>
<td>Emerging Market Countries</td>
<td>EM country NCAP considers adding points for PD and AEB</td>
</tr>
</tbody>
</table>

Source: Citi Research
The Company Profile... NVIDIA

**Headquarters:** Santa Clara, California; www.nvidia.com
**FY 2015 Revenue:** $4,682 million
**R&D:** 29.0% of sales
**Interest Expense:** (1.0%)
**Operating Margin:** 16.2%
**Net Margin:** 13.5%
**Net Operating Cash Flow:** $906 million
**Employees:** 9,228 of whom 6,658 were engaged in R&D*
**Sales per Employee:** $507,315
**Working Capital:** $4,817 million*
**Long-Term Debt:** $1,384 million*
**Total Shareholders' Equity:** $4,418 million*
**Market Capitalization:** $11.70 billion as of June 8, 2015
**FY 2015 Automotive Sales:** $183 million
**Top Automotive Customer:** Harman
**Current Automotive Products:** Visual computing modules (VCMs) for infotainment systems, digital cockpits and rear-seat entertainment
**New Automotive Products:** Drive CX cockpit computer and Drive PX piloted driving computer

*As of January 25, 2015, the end of Nvidia’s fiscal year 2015

**Note:** Estimates of the breakdown of Nvidia’s embedded automotive sales were provided by Luca De Ambroggi, principal analyst, IHS Technology.

**Background**

Nvidia was founded in 1993 by Chris Malachowsky, Curtis Priem and Jen-Hsun Huang, who today serves as the company’s president and CEO. According to the company history, it was the founders’ [pre-scient] belief that “the PC one day would become a consumer device for enjoying games and multimedia.” Nvidia launched its first product, a PCI card featuring a 2D and 3D graphics core, in 1995. The founders took the company public in 1999, the same year Nvidia invented graphics processing units.

Used primarily for 3D game rendering, GPUs became known as the engine of visual computing. GPUs are orders of magnitude more efficient than CPUs (central processing units) at handling multiple tasks simultaneously. A CPU consists of a few cores optimized for serial processing, whereas a GPU has a massively parallel architecture consisting of thousands of smaller, more efficient cores. Nvidia has shipped more than a billion GPUs.

“People are turning to GPUs not only for visual computing but also for nonvisual things like deep learning and speech recognition,” said Danny Shapiro, senior director of Nvidia’s automotive business.

Until recently, Nvidia served three principal markets: gaming, enterprise, and high performance computing and cloud. One year ago the embedded automotive market segment was added to the list of markets on which Nvidia is focused. “Our automotive team is growing rapidly,” said Mr. Shapiro.

**Automotive**

Deployed in CAD equipment, Nvidia technology has for years been used by carmakers to design, engineer, test, market and sell vehicles. Today the auto industry is the largest end-user segment served by Nvidia’s $833 million Quadro Enterprise market platform business. This Nvidia profile will not focus on the Quadro business, but on Nvidia’s embedded automotive business.

A group devoted to designing Nvidia technology into vehicles was started roughly ten years ago. In fiscal 2015, sales of Nvidia products embedded in autos reached $183 million, 4% of total revenue. While some individual GPUs from Nvidia are in embedded applications, FY 2015 sales consisted almost entirely of visual computing modules, which are used primarily in infotainment systems and are also applied to clusters and rear-seat tablets. Automotive accounts for 24% of Nvidia’s Tegra business.

Models from Audi, BMW, Honda, Tesla, VW, Porsche and Lamborghini are or soon will be equipped with Nvidia processors. In 2015, eight million vehicles had Nvidia processors aboard. By 2020 the number of vehicles in the fleet with Nvidia...
NVIDIA

Distinctions Claimed by Nvidia

- World leader in visual computing
- More than one billion GPUs shipped
- Invented the GPU (graphics processing unit) in 1999
- Eight million cars on the road with Nvidia processors in 2015
- Twenty-five million additional cars on the road with Nvidia processors expected by 2020
- Drive CX is the industry’s most advanced visual computing platform.
- DIGITS DevBox is the world’s fastest desk-side deep learning machine.

There is much that distinguishes Nvidia from its competitors:

- GPUs are perfectly suited to visual computing and to deep learning, two technologies that are crucial to automotive advancements. Nvidia invented the GPU.
- Situated in Santa Clara, in the heart of Silicon Valley, Nvidia has a software-first mentality. Software is the means by which carmakers distinguish their vehicles from the competition.
- Nvidia is especially close to Tesla, the electric vehicle maker who has been providing over-the-air software updates to its vehicles since 2012, years ahead of other carmakers.
- Nvidia is also especially close to Audi, another very innovative carmaker. Nvidia technology is at the heart of Audi’s high-end infotainment system and is also slated for use in ADAS systems from Audi.
- Nvidia’s computer platforms, which include GPUs, CPUs and other hardware, plus software, set the company apart from traditional chip suppliers in terms of added value.

Visual Computing Module

In fiscal 2015 all of Nvidia’s embedded automotive revenue came from one product line: its Tegra visual computing module (VCM), which is based on Nvidia’s Tegra SoC. The Tegra integrates a multicore ARM CPU, an Nvidia Kepler GPU, and dedicated audio, video and image processors to enable customized infotainment system graphics and digital instrument clusters. According to the company, the Tegra SoC consumes an order of magnitude less energy than a typical CPU. In addition to the Tegra SoC, visual computing modules include DRAM, NOR Flash and the back side has automotive-grade ball grid array.

The visual computing platform comes with about nine million lines of software code, mostly middleware for image processing, speech recognition, computer vision and deep learning, as well as application program interfaces and graphics libraries. Also included are the operating system (QNX, Linux or Android) and drivers for peripherals.

“The visual computing module is able to run multiple applications and third-party software,” said Mr. Shapiro. Audi and Tesla both employ Nvidia’s VCM. “[And yet] the infotainment experience inside an Audi is very different from the driver experience inside the Tesla Model S. Audi is running QNX as the operating system; Tesla is running Linux. A lot of the core software from Nvidia is leveraged by each automaker; it’s the application layer that makes it different. You can have different speech recognition engines, different mapping databases and different displays, a touch screen in the case of Tesla and the MMI controller in the case of Audi.”

Honda is deploying Nvidia VCM-based infotainment systems running the Android operating system. Fujitsu Ten is Honda’s tier-one supplier.

Continued on following page
Drive CX and Drive PX

In January 2015, Nvidia introduced two new car computers: Drive CX for digital cockpit systems and Drive PX for ADAS and piloted driving. The new Drive car computers are built around the new Tegra X1 SoC, referred to by Nvidia as its “mobile super chip.” On the chip are specialized processors including a powerful Nvidia 256-core GPU, an 8-core, 64-bit ARM CPU, along with dedicated audio, video and image processors. The CPU has four high-performance cores and four energy saving cores, which can flip back and forth between full performance and energy efficiency.

“I am truly amazed by this new Tegra processor,” said Mr. Shapiro. “It is the size of your thumbnail and delivers one teraflops of performance. That’s one trillion floating point operations per second. If you go back to the year 2000, our country’s fastest supercomputer was a one teraflops machine. It took up 1,600 square feet of a data center.”

Tegra X1 provides years’ worth of headroom to accommodate future software updates. “Some carmakers have underinvested in their vehicles’ infotainment system electronics,” cautioned Mr. Shapiro. “As a result they end up with an underpowered system that took three to seven years to develop. By the time it comes to market, it is woefully inadequate for what it was initially supposed to do. In contrast, Tesla asked what is the state of the art in consumer electronics and they put that in their vehicles in 2012. That same Tegra chip (Tegra 3) is still shipping today. Tesla has been able to continually delight their customers by updating the software over the air without having to change the hardware.”

The Drive computers come complete with software including a choice of operating system and middleware. Tegra supports multiple operating systems, including Genivi-compliant Linux, QNX CAR2 and Android, as well as Android Auto and Apple CarPlay device-to-car connectivity software.

Tegra X1 supports all major graphics standards including OpenGL 4.5 and the Android Extension Pack.

◆ Drive CX

Drive CX is a complete cockpit computer platform, capable of driving up to 16.8 million pixels on multiple displays such as high-resolution digital cluster, infotainment, head-up display, virtual mirror and rear-seat entertainment. It can support 3D navigation, natural speech processing and image processing for driver assistance. Drive CX comes with a full software stack including board support package and middleware in a single DIN package. It is scalable from entry level to premium systems. The computer can also handle smartphone projection via Apple CarPlay and Android Auto and can support surround-view camera systems. Drive CX is also available with the Tegra K1, the X1’s predecessor.

“Think of Drive CX as a powerful personal computer for the car, shrunk down into a one-DIN box,” said Mr. Shapiro. “It’s modular; it has slots for additional modules and options. It can have camera inputs, radio tuners, a modem and a variety of different peripherals, inputs and outputs.” CX reference design units are currently shipping.

◆ Drive PX

Nvidia will continue to grow its business in graphics display applications in vehicles, but the demand for driver assistance and self-driving applications will far exceed it over time. Today, infotainment is the dominant application for Nvidia processors, but the future belongs to advanced driver assistance systems and the driverless car. “In the coming years you will see a huge shift to driver assistance as our customers adopt Drive PX, our highly programmable, auto-pilot car computer,” noted Mr. Shapiro. “Once we reduce the number of accidents, injuries and fatalities, ADAS features such as pedestrian detection, collision avoidance and driver monitoring could likely be

Continued on following page
mandated and become standard. Exactly when that happens is hard to predict.”

Mr. Shapiro is seeing great interest and demand for Drive PX. In May 2015, Nvidia began shipping its first Drive PX development units, priced at $10,000 each, to carmakers and tier-one suppliers for ADAS development. Pricing for high-volume, production units has not been disclosed.

Drive PX is powered by dual Tegra X1 mobile super chips. Each Tegra X1 delivers 1.3 gigapixels per second throughput, giving Drive PX enough horsepower to handle 12 two-megapixel cameras at rates up to 60 frames per second. It is equipped with 10 GB of DRAM memory. It can also take lidar, radar and ultrasonic inputs to build a 3D map of everything that’s going on around the vehicle. “Drive PX is designed to be the brain of the self-driving car,” said Mr. Shapiro.

Not yet in production, Audi’s zFAS central driver assistance control unit employs both a Tegra processor and a Mobileye EyeQ SoC. “Mobileye is doing some of the forward facing things,” said Mr. Shapiro. “The other surround cameras are feeding into the Tegra processor, but there is no reason why we couldn’t do the forward looking system as well. … The day after Drive PX was announced at CES in January 2015, Audi’s head of electronics, Ricky Hudi, said Audi will be using it for development of their next-generation system.”

Nvidia is working on tools and libraries that will support Drive PX including the frameworks needed for training a deep neural network that will take place in the data center and then run in real time in the vehicle.

GPU-Based Deep Learning

The powerful and efficient parallel processing capability of GPUs is perfectly suited to deep learning—the use of multilevel, deep neural networks to create systems that can perform feature detection from massive amounts of unlabeled data. GPUs can process the data ten- to one-hundred-times faster than CPUs. GPU-accelerated deep learning is already being applied to image categorization and speech recognition, and now researchers see an opportunity to apply the technology to advanced driving assistance systems and self-driving vehicles.

Deep learning goes well beyond computer vision. “We want to be able to interpret everything that is going on around the vehicle and use that as the basis for simple instructions: to accelerate, brake, turn right or turn left,” explained Mr. Shapiro. “Fixed algorithms can work for some of this, but you can’t possibly create an algorithm with a sufficient number of if-then-else statements to respond safely to everything that can happen around the vehicle. So the ability to train a system to infer what is happening and learn behavior is critical.”

Much of the training will happen before the vehicles are produced, but training will continue and cars will get smarter as they are driven by customers. “If there are new signs or new traffic patterns or new vehicles on the road that the ADAS system or autonomous vehicle hasn’t seen before, all that data goes back into the deep learning system in the cloud and the system is incrementally trained,” said Mr. Shapiro. “The carmaker would then send a software update to the vehicle fleet with the new training model.”

The training in the data center will be done with human assistance. “If the deep learning system starts to misclassify things, the data scientist will intervene and for example say no, that is a paper bag not a rock,” said Mr. Shapiro. “The system then back propagates the new information, correcting itself retroactively, and adjusts the factors it uses in its decision making.”

While many carmakers will likely want to do the training in their own data center, to protect the intellectual property that results, the industry could turn to a consortium that would jointly handle the training. It is also possible that Nvidia would provide training as a service.

In May 2015, Nvidia began shipping its Digits Dev Box, a desk-side computer system loaded with GPUs that have been optimized for deep learning research. Designed for use in the data center, the system comes pre-installed with software to support development of deep neural networks. The price for the training system is $15,000.
Augmented Reality Getting Closer

Thus far, HUD projections can reach only a small portion of the windshield. Most of what Nippon Seiki produces provides fields of view no larger than 2 x 4 degrees. It is just now launching what it is calling a wide-screen HUD, which features a 3 x 7 degree field of view. That’s not yet big enough to overlay graphics into the road scene ahead, a HUD-based feature referred to as augmented reality.

Nippon Seiki’s next jump in display size will come in the 2020 model year, when its 5 x 10 or 6 x 12 degree HUDs are ready. “The challenge with those is the large space needed to package the optics behind the dash. Not many cars can fit a HUD that size,” said Nippon Seiki’s Mr. Pullukat.

Last year Continental equipped a demo car with a 5 x 10 degree augmented reality head-up display. That car depicted three use cases: lane departure warning, adaptive cruise control and navigation. “With navigation we overlaid the navigation arrows on the street where you were to turn,” said Mr. Spoelder. Continental is targeting 2019 or 2020 for production of its augmented reality HUDs.

Augmented reality HUDs will be attractive to car buyers, but they will be expensive and likely limited to luxury vehicles, initially. Not only are they physically very large but they are complex. One of the complexities is the requirement to coordinate the driver’s head position with the HUD’s projection so the graphics are properly positioned to overlay the driver’s scene as intended. The HUD must process inputs from a camera monitoring the driver as well as the external sensors.

Texas Instruments’ DLP Chip Set

The imagers used to create the graphics presented by today’s HUD are LCDs. But because LCDs aren’t 100% reflective, it is difficult to get the reflected image bright enough to cover more of the windshield without overheating the device. As an alternative, HUD suppliers are turning to digital light projection (DLP) chipsets from Texas Instruments. At the chipset’s core is a digital micromirror device (DMD) consisting of an array of up to two million highly reflective, individually controlled, aluminum micromirrors, each one corresponding to a pixel.

This past April, Texas Instruments introduced what it says is the world’s first DLP chipset engineered and qualified for automotive head-up display applications. In 2016 Continental will begin mass producing its third-generation HUD. Based on the TI DLP, the new HUD will provide a wider field of view, 3 x 10 degrees in one case. While the field of view in this third generation is not yet large enough to provide the augmented reality experience, it is an opportunity for Continental to deepen its expertise in DLP technology. “For us it is a proving ground for the augmented reality head-up display system,” said Mr. Spoelder.

Along with the digital micromirror device, TI’s DLP chipset includes a DMD controller, a configuration PROM (programmable read only memory) and in some cases, a DMD driver. In service of the wider field of view, the DLP will provide greater illumination: 15,000 candela per square meter, compared with 10,000 for LCD-based HUDs. They will also be able to provide longer virtual image distances. “Our DLPs are used in a majority of the world’s movie theaters; they are capable of providing cinema image quality,” said Alan Rankin, who handles business development for DLP Automotive Solutions at Texas Instruments. “They provide a lot of flexibility. They can support a variety of virtual image distances and are light source agnostic, meaning we could use LEDs or laser diodes.” They can also be paired with a windshield or combiner HUD.

The near future for head up displays is bright. Especially exciting are augmented reality HUDs, which promise to complement advanced driver assistance systems to provide enhanced safety for drivers. But the demand for HUDs designed to assist driving could plateau in the long term as fully automated vehicles eliminate the need for presenting such information on the windshield. ◆

Roundup...

According to the company, its recent sales growth was a result of increased vehicle demand, especially in North America. EBIT margin improved dramatically year over year, from 0.6% to 3.7%. The low EBIT recorded in 2014 was mainly a result of Hitachi’s payment of fines levied by the U.S. Department of Justice for price fixing. Hitachi is in the process of expanding its electrical businesses including electric vehicle powertrains and ADAS.

Pioneer Car Electronics Segment
FY 2015 Sales: ¥355.6 billion ($2.9 billion)
Change from FY 2014: up 2.2%
Segment Operating Margin: 3.1%, down slightly from 2014’s 3.6% margin
Outlook for FY 2016: Sales are forecast to increase by 5.3% to ¥374.5 billion ($3.04 billion). Operating income will decline by 18%, resulting in a 2.4% operating margin.

Overall sales in Japan declined 13.2%. OEM sales in Japan declined, but grew in China and North America, leading to an increase overall. OEM sales are forecast to increase by ¥10.8 billion ($87.7 million) in the next fiscal year. OEM sales, primarily car audio/visual, navigation systems and speakers, accounted for 57% of the Car Electronics segment revenue in FY 2015.

In March 2015, Pioneer completed the sale of most of its Home Electronics and disk jockey business and will focus on growing car electronics sales going forward. Car electronics sales will account for 77% of total sales in FY 2016, compared with 71% in FY 2015. ◆