Audi’s Top EE, Ricky Hudi, on Infotainment

New MIS Platform Developed In House

We sat down with Ricky Hudi last month at the Consumer Electronics Show in Las Vegas. Audi’s top electrical engineer, Mr. Hudi was in town to support Audi chairman Rupert Stadler, who gave a keynote address to a packed Hilton Theater. In recent years, as carmakers deploy state-of-the-art electronics infotainment and driver assistance systems, CES organizers and the general press have been giving carmakers the same attention they give to major consumer electronics companies.

To begin the presentation Mr. Stadler motored on stage in an Audi e-tron Spyder, a plug-in hybrid concept vehicle that employs four asynchronous traction motors, one at each wheel. The 313 hp sports car can accelerate from zero to 100 km/h (0 to 62 mph) in 4.8 seconds.

“Some of the world’s most exciting electronics are not in the home, they’re in the car,” said Mr. Stadler. One of the highlights of his presentation was Audi’s new infotainment system, the Modular Infotainment System (MIS) developed under the tight supervision of Ricky Hudi and his staff. Following the growing trend among carmakers to bring infotainment system development in house—as Ford did with its second generation Sync and Toyota did with its new Entune system—Audi took charge of MIS development.

Audi decided to take development in house because the complexity of its infotainment systems had reached a point where it was beyond the ability of tier-one suppliers. “The tier-one suppliers, Aisin, Denso, Bosch and Harman Becker, have all been struggling with the complexity,” said Mr. Hudi. “You need very competent people in charge to bring these systems to market.”

Audi’s Top EE, Ricky Hudi, on Infotainment

The auto industry is becoming increasingly reliant on cellular carriers to provide affordable wireless connectivity to and from automobiles. That reliance started in the mid-1990s with OnStar and has been building slowly to a tipping point where today almost every major carmaker on the planet is delivering, or is planning to deliver, important automotive features based on a limited and sometimes scarce resource, cellular radio spectrum.

“There has been a dramatic change in the last year,” noted David Haight, vice president, emerging devices for AT&T. “A year ago carmakers were trying to figure out whether to embed a [cellular] module in a vehicle for diagnostics, safety and security or whether they should utilize the handset modem coming into the vehicle. The common thinking now among all of them is they have decided they have to do both.”

Ford Sync, for example, relies on a smartphone brought into the car to provide connectivity. The new Ford Focus Electric, however, will also employ an onboard wireless modem to enable the MyFord Mobile application. MyFord Mobile allows vehicle owners to remotely control charging and other vehicle functions from their smartphones.

Aeris Communications vice president of sales, Paul Drysch, sees the same trend. Avis is the carrier working with AT&T to provide telematics services for the Hyundai Blue Link connectivity platform due out this June on the new Sonata and Veloster models.

“In the industry there will be both a tethered and an embedded phone,” said Mr. Drysch. “The embedded phone handles anything that touches the vehicle bus. A nothing infotainment related, like Pandora, will leverage the consumer’s handset plan. That sounds great when you have unlimited data plans, but nobody knows where data plan prices are going. So the car companies are a bit worried.”

While the pricing of data plans and wireless congestion could be an issue for infotainment, it does not concern Mr. Drysch. “Congestion could work in Aeris’s favor because of the way we build our network. Our network is dedicated 100% to telematics, so it bypasses most of that consumer type of infrastructure.” Avis is a carrier like Sprint or Verizon, but it doesn’t own towers. Rather, it has roaming agreements with the other carriers.

Wireless Data Congestion

Increased Data Usage Could Upset Carmakers’ Telematics and Infotainment System Plans

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Data Usage on the Rise

Until recently AT&T was the only carrier in the U.S. offering the exceedingly popular iPhone, and as a result has experienced an unprecedented growth in data traffic and congestion.

“The congestion you read about is tied to a couple of cities, notably New York and San Francisco,” said John Kampfe, who handles consumer industry analyst relations for AT&T. “It’s tied to an abundance of smartphones trying to ping a single cell site at a particular time. Spectrum is not infinite, bandwidth is not infinite. It’s a law of physics.”

Because of its congestion problems and unhappy customers, AT&T has had to stop offering new customers its $30 per month unlimited data plan. Instead it offers two plans that cap data usage. The $15 per month plan limits usage to 200 megabytes of data. Users exceeding that limit are billed an additional $15 for another 200 megabytes. For $25 per month, users get two gigabytes of data; going over that limit generates a $10 charge for an additional gigabyte.

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Harman’s Aha Radio

The infotainment industry is being challenged by smartphones and smartphone apps, which not only offer alternative entertainment and information products, but add a difficult layer of engineering complexity as carmakers worldwide attempt to safely integrate smartphones into the vehicle. Harman International, the world’s number-one infotainment system supplier, took a bold step to co-opt rather than compete when it acquired Aha Radio this past September. Formerly known as Aha Mobile, the company was a small venture capital-funded startup whose expertise is converting Web-based content into streaming mobile radio.

I downloaded the free Aha Radio app onto my iPhone and from a choice of some 130 podcasts, Aha stations and Twitter feeds, selected the things I would most like to listen to while driving. For example, I am often disappointed when my short drives don’t coincide with NPR’s hourly news updates. By selecting the “NPR hourly” podcast I can listen to the latest update anytime I jump into my car.

I also selected the Aha Radio station “Hungry,” and inputted my favorite food, Mexican. Now when I hit the Hungry button, I get a list of all the nearby Mexican restaurants in order of proximity. I can find their location and then hit the call or Yelp button for more information about the restaurant, including reviews. I couldn’t, however, get Aha Radio to read the reviews to me as it does with its other stations, for example, Facebook postings and Twitter feeds. In a few years Aha expects to offer thousands of channels from which consumers will select their favorites.

While the iPhone is Aha Radio’s only mobile platform thus far, the company is working to make its content available not only on other smartphones, but more importantly, aboard new and used vehicles. Consumers will be able to take advantage of the vehicle’s user interfaces including touch panels, steering-wheel switches, microphones and speakers.

In January 2011, the company announced its first deal to make Aha Radio available on an automotive platform. Starting in March 2011, two new aftermarket navigation head units from Pioneer will be equipped with software that can accommodate an iPhone running the Aha Radio app. The iPhone will connect to the head unit’s USB port via a 30-pin cable, providing a safer, less distracting interface. “A lot of people today might keep their smartphones on the car seat or tucked under their leg, and every time they are at a stoplight kind of look down to read it—not a good idea. Now they can hear all their Facebook updates read aloud through the car speakers,” explained Karen Rubin, a product planning director for Pioneer.

Other automotive platforms are in the works. As the largest supplier of infotainment head units to carmakers, Harman is well positioned to integrate Aha Radio API into its original equipment and aftermarket offerings. Designed to require only a small amount of computing power, the Aha Radio API is flexible, so it can run on many different types of head units—from high-end radios with big color displays to low-end models with two-line alphanumeric displays.

The Appeal to Carmakers

In addition to its consumer appeal, Aha Radio promises to simplify the job all carmakers are grappling with: integrating Web content safely into the vehicle and keeping that integration up-to-date. In their efforts to keep current with rapidly evolving consumer demands, some carmakers have already integrated Pandora Radio, for example, into their head units.

Roderick MacKenzie, vice president of business development for Aha Radio, sees a role for Aha Radio in providing a standard interface for any Web content that can be converted to audio format. “So, after a carmaker has integrated Pandora, he might want to integrate Facebook next, and then there’s Twitter. What’s the hot app that will come along next year? Then there are the software updates. Carmakers are realizing this is going to be a huge resource drain,” he said. “Because Aha can handle lots of different sources of content by the same mechanism, it makes it very simple for the car company to integrate Web content into their vehicles. If Pandora decides to change their streaming format someday, we could make the

What Is Aha Radio?

Aha Radio is a cloud-based smartphone and vehicle service that aggregates a selection of some of the best information from the Web—including podcasts, music, news, traffic information, even Facebook and Twitter—and makes it safely accessible to the driver by converting text to audio format. For example, Facebook posts and traffic reports are read to the driver via text to speech. Already an iPhone application, Aha Radio is designed to link into the vehicle’s head unit and user interfaces.

Carmaker Benefits

OEMs need not become apps aggregators or programmers or worry about keeping the vehicle’s application programming interfaces to Web content up to date. Aha Radio will handle that as well as shaping apps for automotive consumption. Cooperating carmakers might also take a share of Aha Radio advertising revenues.

Benefits to the Consumer

Drivers get safe, interactive access to a selection of roughly 130 music, talk, information and social media sites from the Internet, with many more on the way.

Aha Radio’s Revenue Sources

Its business case is similar to FM radio’s, though a much improved version because Aha Radio is customizable and interactive. Revenue will come from paid ten-second audio advertising spots and potentially from paid subscriptions.

The Hansen Report on Automotive Electronics

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and experienced people who are able to define the system and bring all the partners together. ... Five years ago we decided to develop our own HMI software. A nd with this generation we are not only doing the HMI but much more of the software. O ur approach to M IS development has been much more efficient than all the other ones I have seen in the last decade."

T he software framework for M IS was developed by the A udi subsidiary e.solutions a joint venture between the software developer EB, which owns 51% of the company, and A udi, with 49%. "W e have a dedicated team of 100 engineers at e.solutions, and we are very happy with the work they are doing," M r. Hudi said.

By taking infotainment development in house, he noted, development costs were significantly less, and the price A udi will pay to H arman to deliver the head units will also be significantly less. Be- cause it is a vehicle’s most complex sys- tem, infotainment development has in the past engaged hundreds of the carmakers’ and the suppliers’ engineers and cost carmakers tens of millions of dollars.

A udi’s M IS provides arresting 3D graphics, dual-zone and online video, and connectivity to data and services from outside the vehicle, for example Google Earth navigation, a world’s first for A udi. T he carmaker plans to have no data stor- age aboard the vehicle; rather, it will pull all its information from the Internet. M IS will first be installed on the 2012 A udi A 3 and later across all new A udi models as well as some V olkswagen G roup models.

N ot only did A udi create the software platform, but because it organized the hardware development, it also owns the intellectual property for almost everything in the platform except the computer chip, which comes from N vidia. T he software framework supports reuse; the hardware and software can be updated without having to rewrite and test all of the code.

T he N vidia Tegra graphics processor at the heart of the system has eight ARM cores in it. N vidia supplies the processor and the M MX (multimedia extension) board on which the processor is mounted. T he M MX board handles high-level func- tionality such as telephone, navigation, video and the Internet connection. By decoupling the multimedia computing from car-specific functions, which don’t change as rapidly, M MX helps shrink the gap between consumer electronics and automotive design cycles.

A ccording to N vidia, a key advantage M MX brings is its low power consump- tion. In addition to front-seat infotain- ment applications, M MX can also be used in rear-seat entertainment and digital cockpits. Future versions will support camera-based driver assistance systems.

H olding the snap-in M MX board in his hand, M r. Hudi explained, “T his has everything you need to make a high-end notebook computer; it is the most ad- vanced mobile computer the world has seen.” N vidia’s M MX board snaps into the one-DIN head unit board made by H arman. H arman will buy the board from N vidia and collect revenues that cover its cost. A s a result, H arman’s value added is less than if it produced the M MX board.

Yes on MOST 150; No on Genivi

The German carmakers are usually in agreement on standards, but A udi has been unwilling to join B MW in two stan- dards that B MW has been advocating: G enivi and Ethernet. M r. Hudi said he is definitely sticking with A udi’s own infotainment system platform. “W hen we started work on our own platform, we had discussions with B MW. I t became obvious in our first meeting that G enivi’s time line doesn’t fit with our own.” B MW is planning to introduce G enivi in a 2013 model-year vehicle; A udi’s new platform will be out a year sooner.

B MW has also been advocating for an automotive Ethernet standard, but A udi will use M O ST 150, as will V olkswagen in its high-end infotainment. U nlike Ethernet, M O ST technology is proprietary and relatively expensive. “Ethernet probably has other costs due to its complexity. W e have good experience with M O ST. W e were the first to introduce M O ST 25 and are now the first to introduce M O ST 150,” M r. Hudi noted.

A ha Radio...

changes on the backend, and no updates to the car will be necessary."

“Future proofing is one of the strongest value propositions we bring,” said Robert A cker, A ha Radio vice president, general manager and founder. “W ith our platform, the car radio can still get the very latest Web content five years from now, com- pletely new content nobody would have dreamed of when the radio was devel- oped.” U sing Facebook as an example, M r. A cker remarked that, given the typical automotive design cycles, if carmakers had tried to do a social media implementation, they’d be launching M ySpace channels today. “W e take the Web content and make it work in their particular head unit. If they have an iDrive [multifunction con- troller], or a touch screen, or hard buttons, or voice control, or steering-wheel con- trols— we can work with any of them.”

A ha Radio Revenue Potential

Based in Palo A lto, California, A ha Radio had just five employees before it was acquired by H arman, but will grow to a team of 25 or 30 within the next few months. T he company does not own the back-end service that runs the A ha Radio platform; it is leased from A mazon W eb Services. W ith such a small investment in people and infrastructure, H arman could realize substantial returns if A ha Radio becomes the platform of choice for millions of people in their vehicles. T he com- pany is working with carmakers who want to run the A ha Radio platform on their head units, but it also plans to work through dealers and possibly even go di- rectly to consumers through e-commerce channels to get the product into the after- market.

T he faster A ha is able to ramp up widescale deployment of its content aggrega- tion service, the sooner it will begin generating revenue from very accurately targeted advertisements.

“T he revenue opportunity we are look- ing at from advertising is much bigger than $100 million per year. A nd the margins are very high,” said Dinesh Paliwal, chairman and C EO of H arman.
The Company Profile... National Semiconductor

**Background**

National Semiconductor came into existence in 1959, in Danbury, Connecticut, through the efforts of eight former Sperry Rand Corporation engineers. Among the first companies to set up shop in Silicon Valley in the late 1960s, National acquired Molectro Corp. and began producing voltage regulators and operational amplifier ICs (integrated circuits). Over the last 50 years various National Semiconductor products, notably memory devices and analog ASICs, have found significant applications in the auto industry. In 1987 National acquired Fairchild Semiconductor, which brought a line of discrete automotive power devices. National sold Fairchild in 1997.

**Automotive**

National has been a pioneer in LVDS (low voltage differential signaling) and Ethernet technologies. Recently, National’s expertise in high-speed video transport has given the company a solid footing in the auto industry with its FPD-Link (flat panel display) serializer and deserializer (SerDes) ICs, which are used by carmakers to transport high-speed, uncompressed digital video signals over inexpensive cables. The company is also finding a receptive audience with electric vehicle developers, who are keenly interested in National’s battery management chipsets and boards, and with developers of LED lighting applications, who want constant current driver ICs. Automotive applications accounted for 7% of National’s revenue in FY 2010.

**FPD-Link, High Speed Video Transport**

With increasing penetration of high-end infotainment and driver assist systems, carmakers have adopted better quality, higher resolution digital cameras and video displays. National has been investing heavily in further developing its LVDS technology to serve that growing market.

Michael Hendricks, senior marketing manager for National’s high speed data path business, explained: “National’s FPD-Link II and FPD-Link III SerDes ICs were developed specifically for automotive applications to transport high-speed uncompressed video from sources such as a graphics processing unit or digital cameras to a display. The benefit to the auto industry is they can deliver high-speed, uncompressed video over a single, low cost, lightweight, unshielded twisted-pair copper cable.” LVDS signaling also offers low EMI and high immunity to common-mode interference.

Instead of transporting digital video data in a cable with 16 or even 32 parallel paths, which would be very cumbersome to route in a vehicle, an FPD-Link serializer converts the parallel streams into a single stream of bits. The deserializer reassembles the data back into parallel paths for processing or display. National’s serializer/deserializer components are designed to transport extremely fast data...
signals at gigabit rates are analog difficulties, the difficulties of transporting those analog products. While its FPD-Link ICs are known today for its high-performance video transport, FPD-Link technology, according to Mr. Hendricks, is adaptive equalization: "At gigabit frequencies, you see an accumulation of signals and reflections, which are analog problems. If you look inside a serializer/deserializer, you see such things as a PLL (phase-locked loop), clock and data recovery, equalization, signal conditioning and cable driver circuits—all analog."

National's experience with video transport goes back to its work some years ago with makers of laptop computers. "You had a limited space to be able to move data through the hinge," said Mr. Dietz. "Now as the auto industry moves to 720p resolution HD video with its improved color depth, we have been drawn into those high-speed automotive video transport applications."

Demand for National's SerDes circuits began with some of the German carmakers and from there spread to Japan, where Alpine, Pioneer and Clarion started bidding for German infotainment system business. National's SerDes circuits are also in use by some Japanese infotainment system suppliers serving the aftermarket. "Today, the FPD-Link products account for roughly 10% of our business in Japan and is one of our fastest growing segments there," said Jeff Waters, regional vice president for Japan. "While the proliferation of high-quality video in Japanese cars now is much lower than in German luxury cars, Japanese carmakers are beginning to embrace Blu-ray DVD players and HD video. National is hoping to win some SerDes business from the suppliers who serve Toyota, Honda and Nissan, whose quality and product support requirements are more rigorous than even the German carmakers."

**LVDS (FPD-Link) Best in Point-to-Point Applications**

FPD-Link's ability to handle uncompressed video gives it an advantage over Ethernet and MOST in point to point communications, according to National's Mr. Hendricks. "If you used MOST or Ethernet the signal would have been bandwidth, uncompressed video from source to display. The first generation FPD-Link was developed to link laptop computers to their displays through a ribbon cable. The second generation, FPD-Link II, requires only a single twisted-pair copper cable. Designed to minimize EMI, its embedded clock architecture is well suited to automotive applications. FPD-Link III requires only a single twisted-pair copper cable to connect the camera to the display or video processor."

**FPD-Link Serializer/Deserializer Product Evolution**

National's line of FPD-Link ICs use LVDS (low voltage differential signaling) technology in linking high-bandwidth, uncompressed video from source to display. The first generation FPD-Link was developed to link laptop computers to their displays through a ribbon cable. The second generation, FPD-Link II, requires only a single twisted-pair copper cable. Designed to minimize EMI, its embedded clock architecture is well suited to automotive applications. FPD-Link III requires only a single twisted-pair copper cable to connect the camera to the display or video processor.

**Number one automotive market share for uncompressed video transport in infotainment and driver assist (FPD-Link II SerDes)**

**First to market with 720p HD resolution SerDes with high bandwidth digital content protection**

**Industry's first integrated real-time bidirectional control channel (FPD-Link III SerDes)**

**Pioneer and inventor of low voltage differential signaling (LVDS)**

**Best in class LED driver dimming and efficiency performance for LED backlight displays**

The analog challenges come from the media: the circuit board, cabling and connectors," said Erroll Dietz, vice president of National's High Speed Products Division. "At a gigabit frequencies, you see a great accumulation of signals and reflections, which are analog problems. If you look inside a serializer/deserializer, you see such things as a PLL (phase-locked loop), clock and data recovery, equalization, signal conditioning and cable driver circuits—all analog."

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to be compressed and then decompressed, and that doesn’t work so well, particularly in mission critical applications such as pedestrian detection, where ultra-low latency is paramount. ” MOST 150 operates at 150 megabits per second but FPD-Link can support data rates up to 2.8 gigabits per second. Ethernet can transmit at one gigabit per second.

At least one carmaker, BMW, has said it intends to use the Ethernet protocol in a multi-camera driver assistance system. But National, which sees itself as an Ethernet innovator, believes LVDS is a better way. “Using Ethernet is like using a wrench when what you really need is a hammer,” said Mr. Dietz. “It can probably work but it doesn’t work very well.” Using Ethernet for streaming video applications requires additional and redundant packet processing, according to National, and Ethernet’s software overhead increases the cost and complexity of the microprocessors required in camera and display modules. “Ethernet has too much overhead,” Mr. Dietz said. “It is designed to connect multiple computers in a network over long distances. For point-to-point camera and display links in the vehicle, LVDS is far superior. It is more efficient; you get more bits through the pipe on an LVDS system than you do with Ethernet.”

Displays and Cameras— Fast Growing FPD-Link Applications

National expects its market for SerDes to track with the growth in demand for automotive displays and digital cameras. According to Mr. Hendricks, “Digital cameras [and their high-speed digital links] will be needed whenever you have to do any sort of video processing, for example traffic-sign recognition, pedestrian recognition, and lane-departure warning. A nother area where development is hot is surround-view cameras, where digital images from four or five cameras are stitched together, eliminating any blind spots. Such systems will require as many as 10 SerDes links.”

Much of the expected growth in camera demand is for the analog types used in rearview safety applications, which do not require high-speed connections. Rearview cameras will likely be required in all new U.S. vehicles starting in 2012, with 100% phase-in completed in 2014. Toyota and Volvo have installed driver-fatigue monitors in production vehicles, but Mr. Hendricks doesn’t see this as a fast growing camera application.

National expects global demand for automotive displays to climb to 40 million units per year from 24 million units in 2010, a 10.8% annual rate of growth. “Central information displays are becoming a standard feature in mid-priced vehicles,” noted Mr. Hendricks. “Plus, we are seeing more head-up displays and more digital instrument clusters.” Growth in demand for embedded rear-seat displays will likely be slowed by the proliferation of onboard Wi-Fi hotspots and mobile devices people bring into their vehicles.

Battery Management Systems and Components

With approximately 50 people presently dedicated to the effort, National Semiconductor has been aggressively developing battery management technology with the goal of securing an industry leadership position in the nascent electric and hybrid vehicle component market. That development work has led to two advanced engineering engagements: one European carmaker and one Japanese carmaker have asked National to help them develop their battery management technology. In both engagements the carmakers are paying engineering development fees and paying for samples. One engagement involves active battery cell balancing and the other, passive balancing.

“We will soon be releasing our second-generation active balancing product,” said Mike White, vice president of battery management systems and lighting management for National Semiconductor. “We consider it to be a mainstream product, economically feasible for the marketplace. We are engaged with leaders in the EV market who will be putting their solutions in the market in the 2014 or 2015 model year.”

All of the battery cells in a vehicle’s pack are not created equal. Some charge more quickly than others. To prevent overcharging and thus damaging those cells, current is diverted through a bypass resistor, which wastes energy. With active balancing, instead of consuming unwanted charge as heat, the charge is distributed to the higher-capacity cells. Likewise, all cells don’t discharge at the same rate and as a result, recharging begins before the charge in all of the cells is used up. With active balancing any unused charge is redistributed to the lower capacity cells before recharging is begun.

With electric vehicles, where the focus is on getting as much range as possible out of the battery pack, active balancing makes economic sense. “Active cell balancing solves the problems of battery cell mismatch and the resulting state of charge imbalances, as well as the fact that batteries age unevenly. It improves reliability and performance, and allows the carmaker to give a longer warranty. In some cases it allows the carmaker to get the same range with a smaller battery pack,” explained Mr. Dietz.
Mr. White. “So while you are paying a little more for the battery management system, you are getting a lot of benefits in return. The more cells you have in the pack, the more value you have with active balancing.”

National participated in a field test of an electric bus in China, which demonstrated a 20% to 30% improvement in range as a result of active battery management compared to passive.

A nother economic benefit of the technology, according to Mr. White, is that the electric-vehicle maker should be able to relax the performance requirements of each cell, allowing a wider distribution of performance, which could mean lower cost batteries.

A key component in National’s active battery management chipset is the analog front-end monitor that precisely senses the voltage in each cell. The chipset also includes a precision voltage reference, A to D converter and secondary protection ICs.

Not only has National developed the semiconductor devices that comprise its active management system, it has also developed the printed circuit board assembly that developers can use to test the product. Ultimately, National aims only to produce the semiconductors that populate the assembly. Depending on the size of the battery pack and the complexity of the system, active cell balancing is expected to bring National up to $100 dollars per electric vehicle.

National is also developing products aimed at passive cell balancing applications and is already engaged with a carmaker in an advanced development project that could lead to a production application starting in the 2014 model year. Aimed at hybrid vehicle makers, National’s precision analog and power IC devices in passive balancing applications could potentially bring in up to $40 in revenue per vehicle.

**LED Lighting Drivers**

A nother emerging application National is aggressively investing in to attain early market leadership is LED headlamps, where its constant current driver ICs are expected to play a key role. National’s LED drivers are already used in rear combination lamps, signal lights and in backlighting of automotive LCD displays.

“Half of National’s corporate sales comes from power management ICs, it’s one of our strengths,” said Mr. White. “Several years ago, in anticipation of a growing opportunity for LED drivers in the auto industry, we built a portfolio of constant current drivers that could be used with different types of LEDs and strings of LEDs. That and current control are the real keys to getting steady illumination from an LED.”

The two highest value LED driver applications in autos are headlamps and display backlighting. Over the last two years National has introduced LED display backlighting technology that provides contrast ratios as high as 10,000 to one. “Years ago it was very difficult to see the display accurately in full daylight,” said Mr. White. “With our drivers, displays can adapt to any lighting conditions.”

National sees a lot of promise in the market for LED headlamps. “In the next two years we are going to see a tipping point in forward LED lighting,” declared Mr. White. “In 2009 and 2010, production of LEDs was at full capacity. That has changed this year. We are seeing many new entrants. It’s not just the traditional suppliers like Nichia, Ichikoh, Osram, Cree and Philips Lumileds. Significant new production capacity is coming. And further, LEDs are being produced with more and more lumens per watt. All of this is driving volumes up and costs down,” he said.

Ultimately, Mr. White expects LEDs to overtake not only HID (high-intensity-discharge) headlamps but even incandescent headlamps and not just in electric vehicle applications. “If LEDs are treated well, they will last 50,000 to 100,000 hours. They are shock resistant, more efficient, easier to style and require less thermal management.”

National LED drivers sold to Hella for low-beam control are already on the road in Audi vehicles. “Beyond Audi, we are seeing a significant uptick in interest from all of the carmakers to re-evaluate LED forward lighting,” said Mr. White.

LEDs degrade slowly over time, a function of their operating temperature. Among the features designed into National’s LED driver ICs is what the company calls thermal foldback, which monitors LED temperature and slowly diodes back the current to bring it into a safe operating range. A nother feature of National’s LED drivers that helps optimize lighting efficiency in infotainment system backlighting is DHC (dynamic headroom control). DHC monitors output and adjusts output voltage to the lowest level required to maintain accurate driving current.

National expects to sell a significant volume of its driver ICs in headlamp applications in the 2014-2015 timeframe. Each vehicle with LED headlamps will need between $5 and $15 worth of its drivers.
Wireless...

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Systems, wireless technology developer InterDigital reported that demand for data will rise from 220 megabytes per month per device at the beginning of 2011 to nearly 1.8 gigabytes per device per month by the beginning of 2014 and continue upward from there.

In the face of this explosive rise in wireless data traffic, carmakers are deploying telematics and infotainment systems that depend on affordable, uncongested cellular networks not only to function but to receive software updates. Infotainment systems will access the Internet and cloud computing resources to deliver features such as speech recognition, map and point-of-interest-data, traffic information, access to social networking sites, and access to audio and video content. Carmakers are provisioning their vehicles with onboard Wi-Fi hotspots to link passengers’ mobile devices and laptops to the Internet by means of cellular networks.

In-vehicle users will expect to be able to use their computers as they do at home, but applications that move data upstream, for example posting video to their Facebook page from the vehicle, could be problematic. One particularly data hungry application that could find wide use among passengers is FaceTime, a video calling application.

What the Experts Say

If data congestion has already been severe enough to affect pricing, will the situation just get worse as data usage continues to surge? Will data prices also surge? Will automotive features that rely on cellular communications either stop working or be degraded by heavy congestion? I put those questions to the carriers and some other experts, and here’s what I learned.

Will data congestion be a problem? “In the short term, carmakers do need to be worried,” warned Berge Ayvazian, senior consultant and director of the 4G consulting practice at Heavy Reading. “At the moment we are overloading networks. It’s a problem particularly in large metro areas where there is a high concentration of users. That’s where you have people in their cars sitting in traffic all trying to do the same thing; they’re downloading entertainment, engaging with their apps.”

“Over the next three years, things will begin to improve somewhat as the carriers build out their 4G networks,” said Mr. Ayvazian, “although 4G coverage for some carriers will not be as good as their coverage was with 2G or 3G. Network capacity is cyclical. Traffic will ease up for a while and then get congested again. Once you expand capacity it fills up. It’s just like highways— you build something you think has plenty of capacity and in a year it’s full again.”

Carriers’ Plans Will Affect Carmakers’ Plans

The carriers I spoke with all told me that they are aware of the explosion in mobile data and are making the necessary investments to keep pace with it. AT&T, Sprint and Verizon all pointed to their plans to roll out 4G networks as a key solution, but they were unable to say quantitatively how much better their 4G networks will perform compared with their 3G networks.

In his presentation at the World Telecommunications Congress last fall, InterDigital’s Mike Wrape included a chart that suggested LTE (4G) alone, with its three- to five-times capacity improvement over 3G, will not be nearly enough to cover the data demand, which by 2014 will reach nearly 1.8 gigabytes per month per device, exceeding 3G capacity by twenty times.

AT&T, with 25 million smartphone subscribers in the U.S. at the end of 2010, compared with 17 million smartphone subscribers for number-two Verizon, has been a victim of its own success as the exclusive provider of the popular iPhone. But AT&T’s congestion problems will likely be relieved somewhat now that Verizon is also supporting iPhones, something it just began on February 10, 2011. “The most capacity-constrained of the carriers, AT&T, has been offloading some data traffic to its Wi-Fi hotspots,” noted Mr. Ayvazian. “AT&T owns and operates the largest public-usage Wi-Fi network in the country. Besides rolling out LTE this year, they are investing in new backhaul and in new spectrum.” AT&T is also adding cell sites, though doing so in San Francisco, where its networks have been particularly congested, has been difficult due to local regulations.

“We are seeing data usage double every year in our network,” said Mark Emerick, a network director at Verizon. “We continue to invest billions of dollars in our network, not just in our 4G network but also our 3G network. ... Verizon recently purchased a 25 MHz block of spectrum in the 700 MHz band that could essentially double our spectrum in some markets. ... By the end of 2013, we will have built out 100% of our existing 3G footprint with LTE. And further, we are partnering with rural operators across the country to lease our 700 MHz spectrum to them so they can build out LTE as well.”

For its part, Sprint will invest between $4 billion and $5 billion over the next three to five years to deploy a new nationwide network that brings together multiple spectrum bands (800 MHz, 1.9 GHz and 2.5 GHz) on a single multimode base station.

“There will be some road construction along the way. [But] thus far the vast majority of our customers have been happy with their 300 megabytes of data per month,” said Tim Johnson, emerging solutions strategic opportunities manager, Sprint Nextel Corporation.

Carmakers have two separate sets of considerations to make regarding their reliance on wireless connectivity. For embedded applications involving safety, security and diagnostics, it is a matter of understanding each carrier’s end-to-end capabilities, projected well into the future, and choosing the right carrier. For features that depend on the customer’s own smartphone and data plan, the carmaker should have a clear picture of what his customers’ cellular data future looks like and create an infotainment system that flexibly accommodates all future scenarios. Rather than relying entirely on his customer’s wireless connection for all infotainment features, he could choose to deliver some of them using the embedded connection, for example, cloud-based speech recognition.