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*HMI a Bigger Challenge than Robotics*

Engineers have been in a space race to deliver cars that can self-drive on expressways without the need for human supervision, allowing drivers to do more engaging things with their time behind the wheel. The feature would be a boon to commuters. Multiple carmakers targeted 2020 for introduction of the feature, but some of their plans have slipped to 2021 or later, or have been canceled entirely.

In a speech given August 16, 2016, at Ford’s Palo Alto, California, facility Raj Nair, executive vice president for product development and chief technical officer at Ford, said that the carmaker has “abandoned a stepping-stone approach [to full autonomy] and decided to take the full leap to deliver a fully autonomous [SAE] Level 4 capable vehicle … with no driver controls, commercially available for ride-hailing or ride sharing services in 2021. … The challenge with Level 3 is that we don’t yet know how to manage driver re-engagement.” You can see the Ford presentation [here](http://www.hansenreport.com).

Traffic Jam Assist, due within the next three years from Ford, will be SAE Level 2, requiring the human driver to monitor the driving environment at all times. Ford said it will be ready to sell autonomous cars to private owners by 2025.

**Level 3 Challenges**

Here’s the problem. Consider a Level 3 piloted expressway driving system that autonomously takes the vehicle from entry to exit ramp. The human driver can do what she wants while at the wheel, but needs to quickly and safely re-engage in the driving task as the situation warrants.

Changing lanes autonomously, required to get out from behind slower traffic or to prepare for an expressway exit, will frequently demand driver engagement, especially when traffic is dense. The complex operation involves a considerable amount of give-and-take with vehicles in the adjacent lane. Your vehicle must nudge or even bully its way into a space that’s too small and see if the other driver will give way. If he does, it can merge. If not, it must wait for another opportunity. Merging...
is a common driving scenario, and nobody knows for sure how or whether this can be done safely without driver intervention. The problem is an appalling lack of science around the autonomous vehicle’s human machine interface. “Much of the population hasn’t even experienced adaptive cruise control, let alone semi-autonomous driving,” cautioned Jeff Ruel, director of business development for active safety systems at Autoliv. “How do drivers react in different situations? How do you effectively bring them in and out of the loop? What sort of training do drivers need? We don’t know.”

In recognition of the missing HMI piece, Autoliv has partnered with Delphi, Liberty Mutual Insurance, Jaguar Land Rover and Toyota in the Advanced Vehicle Technology (AVT) Consortium, part of the Massachusetts Institute of Technology AgeLab. Bryan Reimer, a research scientist at the AgeLab, is lead researcher at AVT and associate director of the New England University Transportation Center. Lately his work has focused on the human-centered side of vehicle automation, how humans interact with the automation systems that are rapidly coming into cars. “In some sense it is quite scary,” he warned. “My suspicion, based on what I am being told, is we are going to see L3 in production in two years or less. Because we can. No one is asking the question, from a safety efficacy perspective, if we should. … The most complex component is how do we deal with the human-centered side of re-engineering us. Some of us can’t learn quickly. We have skills that range from probably shouldn’t be driving to professional drivers who are driving 100K miles a year without incident.”

Dr. Reimer would like more companies to participate in the Advanced Vehicle Technology Consortium. “To solve the human-centered problems, the industry needs to work together to understand those problems, collect data and decide how to strategically move forward,” he said.

From a June 2016, AgeLab blog: “The AVT Consortium, which began to collect data in the Boston area this past June, is currently recruiting drivers of Tesla Model S and X vehicles who are willing to have data recording technology installed in their own vehicles. … Present plans call for expanding the scope of the program to recruit owners of 2017 Volvo XC90s and S90s later this summer, and it is expected that other makes and models of semiautonomous cars will be considered as they become available.” Here’s the blog post.
Local Motors is an innovative, low-volume vehicle manufacturer working on several novel projects, one of which is Olli, a self-driving, electric-powered bus that can be hailed and paid for with a smartphone app. By 2018, Local Motors expects to have some pilot demonstrations up and running using vehicles without driver controls. A fleet of Olli buses will have a supervisory system with a human at the helm.

Mathew Lesh, director of mobility systems at Local Motors, believes, “Our main goal is to take the human element out of it. The human is the problem. Every person is different and will behave differently depending on the situation. … We need to take time to understand and absorb human machine interface technology. I would suggest pilot projects in constrained environments to give opportunities to a large number of people to touch and feel the technology before it runs amok.”

More Sensors, More Computing
Apart from the difficulties associated with getting the human driver to respond appropriately to requests to intervene, piloted expressway driving appears doable, but at a cost that might make the technology inaccessible to all but the least price conscious consumers, at least initially. “We will show this [piloted driving] and we are not the only ones,” suggested Alfred Eckert, responsible for advanced engineering for Continental’s Chassis and Safety division. “To do it you need some sensor capacity looking to the rear and to [adjacent] lanes. … And you need more computational power; the system must be able to react to everything that is possible on the highway without alarming the driver.”

Being able to react to everything possible is a very complex problem, agreed Autoliv’s Jeff Ruel: “It depends on where you are, what time of day, the weather conditions, how well the roads are marked, is it a construction zone, is there more ambiguity in the driving scenario than normal? You must deal with many exceptions, for example a retread from a truck in the road. These are just some of the things that a sensing and computing platform has to deal with to navigate. How much computing power and sensing you can afford to put into your vehicle is a matter of economics.”

The Hansen Report on Automotive Electronics, September 2016

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Piloted expressway driving requires not only precision maps, but also improved sensors, according to Bosch director of marketing for the Chassis Systems Control group, Frank Sgambati. Bosch is developing its fourth-generation radar sensors and third-generation mono- and stereo-vision cameras, as well as MEMS 3D inertial measurement units. The highway pilot application can also benefit from ultrasonic sensors. “We will clearly be using those in dense traffic situations,” said Mr. Sgambati.

As for the HMI piece, Mr. Sgambati suggested that driver monitors will be needed. He also noted research underway at Stanford and the University of Michigan, to provide a better understanding of the ability to transition between human and piloted driving. Despite the many unknowns, Bosch is aggressively targeting 2020 for its highway pilot.
The Company Profile: 
Flex Automotive

**Thumbnail Sketch**
FY 2016 ended on March 31, 2016.
Flextronics International Corporate 
Headquarters: Singapore
FY 2016 Sales: $24,419 million
R&D: 0.3% of sales
Interest and Other Expenses: 0.3% of sales 
Net Margin: 1.8%
Working Capital: $1,793 million*
Long-Term Debt: $2,693 million*
Shareholders' Equity: $2,623 million*
Market Cap: $6.94 billion as of August 24, 2016
Employees: 200,000, of whom 2,500 are design engineers
Sales per Employee: $122,095

**Flex Automotive**
Headquarters: Farmington Hills, Michigan
FY 2016 Sales: $2,000 million
Employees: 13,000, including 300 design engineers
Sales per Employee: $222,222
Top Customer: Ford
Sales by Product Category: Connectivity, 33%; Vehicle Electrification, 33%; Clean Technology, 33%

*As of July 1, 2016

**Flex Automotive Background**
Flex Automotive is part of the company’s High Reliability Solutions (HRS) business segment, which also includes a medical business focused on consumer health, digital health, disposables, drug delivery, diagnostics, life sciences and imaging equipment; and a defense and aerospace businesses, focused on commercial aviation, defense and military markets. Steadily growing, the HRS segment has produced year-over-year sales growth for 26 quarters in a row.

In 2011, Flex Automotive moved its headquarters from Stuttgart to Farmington Hills, Michigan, close to most of its automotive customers. Flex Automotive

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The Hansen Report on Automotive Electronics, September 2016
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maintains customer-facing facilities in Farmington Hills as well as Milpitas, California, Shanghai and Stuttgart.

Flex recently added a new Automotive Innovation Lab to its one-million-square-foot Flex Customer Innovation Center in Milpitas. Serving as headquarters for automotive research and development, the facility is able to house confidential work on cars. “There we can combine disciplined automotive execution with extremely fast and responsive Silicon Valley development,” explained Kent Helfrich, vice president and CTO for Flex Automotive. Prior to Flex, Mr. Helfrich spent 20 years with General Motors, most recently as the carmaker’s top electrical engineer.

Automotive sales have been growing at nearly 24% per year since 2012. Automotive sales to customers in China and India grew by five times between FY 2011 and FY 2016. According to the company, Flex-made products are in more than 450 models currently, and that number is growing.

**A Full-Service Supplier**

Flex Automotive is positioning itself to be more like a hybrid tier-one supplier, handling product development from concept through design, to high-volume manufacturing, or anywhere in between. “The High Reliability Solutions segment is where we are focusing a lot of our resources on future growth, becoming a more product focused company,” said Mr. Helfrich. Especially in its HRS segment, including automotive, Flex has been de-emphasizing its electronics manufacturing services business, which can have relatively low margins and short life spans, in favor of its original design manufacturing business (ODM), where it acts as either a tier-one or tier-two supplier.

Flex Automotive has been building this part of its business through acquisitions, in-house development and by selling globally. ODM accounted for roughly

The Hansen Report on Automotive Electronics, September 2016

[www.hansenreport.com](http://www.hansenreport.com)
35% of sales in FY 2016. Plans call for ODM to account for half of the business by FY 2018.

Even as it emphasizes ODM, Flex Automotive’s electronics manufacturing services business will not soon go away. “We are seeing the disaggregation of hardware and software,” said Mr. Helfrich. “The OEM is keeping responsibility for software development and overall system integration in house. This is going to increase the number of hardware manufacturing opportunities.”

A full-service supplier, Flex Automotive’s services include value analysis, value engineering, manufacturing, program management, purchasing, quality control, benchmarking, testing and validation, as well as aftermarket services.

“We can meet our customers’ needs, whatever they are. If that means manufacturing their design or providing a second manufacturing source for lower cost or geographic preference, we will do that. What we find, though, is once we get in and demonstrate our capabilities, we very quickly start moving up the food chain to co-developing and sometimes taking over design and development of an entire module. Being able to offer complete design and build services or manufacturing only is a huge competitive advantage for us,” said Mr. Helfrich.

**48 Volts**

A German carmaker has awarded Flex a contract to deliver “very novel, compact, 12/48-volt dc/dc converters,” according to Mr. Helfrich. The product is on track to start production in the near future. Flex won the business based on its experience delivering energy storage, recuperation and conversion products to commercial vehicle manufacturers in Germany. It first entered the dc/dc converter market with its December 2009 acquisition of Stribel Electronics, based in Frickenhausen, Germany.

Flex has been watching the auto industry’s adoption of 48-volt sub-buses. Initially, it is being driven by the
rollout of high-end cars with power-hungry equipment such as electric turbochargers and features such as electromechanical active roll stabilization. As the price of power conversion and 48-volt machines comes down, 48-volt adoption will be driven by the demand for fuel economy. European carmakers will be the first to embrace 48-volt systems, followed by the Chinese.

**Activity Key Wristband**

“If you are thinking about, say, a wearable for automotive, why not go to an automotive supplier that makes the majority of the wearables in the market today?” suggested Mr. Helfrich. A well known luxury OEM has done just that in sourcing Flex for its wristband accessory. “Imagine locking everything in your trunk, including your keys and smartphone and strapping a very durable, waterproof device to your wrist. You come back to your car from your run or swim and the wearable device opens up your trunk.”

**Overhead Consoles**

Flex Automotive has been making overhead consoles for a German carmaker for five years and has recently won additional business with that same carmaker and also with a U.S. carmaker. As overhead consoles become homes for additional electronics including driver monitors, Flex sees promising opportunities to expand that business. “You want an overhead console supplier that is an electronics company and also a plastics company,” Mr. Helfrich noted. “As a result of our partnership with Aito, we can also make haptic feedback/capacitive touch switches part of the console.”

**Partnership with Aito**

Flex has worked with several startup companies who have great ideas but lack the resources to fully engage with large customers. “Aito is a great example of a company that has promise, and we are helping them figure out how to make automotive grade products,” said Mr. Helfrich. In 2016, Aito and Flex partnered to work on piezo-based embedded touch sensors. Backed by two venture capital funds, Aito is headquartered in Amsterdam, the Netherlands, and operates research facilities in Helsinki, Finland.

Flex will be announcing other partnerships later this year.
Software Development
While Flex Automotive specializes in the design and manufacture of hardware, it can also competently handle software, especially the software that’s related to hardware—the middleware and below, including diagnostics software. Thirty percent of approximately 300 engineers who are employed by Flex Automotive can write software, even application software. Flex has written software for some in-house developed products, but for large software development projects the company works with outside service providers.

Some Automotive Customers
Flex Automotive serves at least twelve major carmakers, but Ford is by far the largest automotive OEM customer. Flex produces in-car connectivity, lighting products, solenoids and motion control electronics for Ford.

Flex is working with the carmaker on new, slim display modules and on the third-generation Sync infotainment system. Panasonic was named as Ford’s tier-one supplier for Sync 3, but Flex is also participating. “We have some design responsibility and some second-source, build-to-print, follower responsibility,” said Mr. Helfrich. “Oftentimes we can be brought in as a lower cost regional supplier.”

While an official award has not yet been announced, Flex has been working with FCA on design and manufacturing of infotainment and a number of other products from the Flex Automotive portfolio.

Flex produces telematics control units and the radio submodule within for Sierra Wireless, a Canadian pioneer in machine-to-machine communications. According to the company, it has shipped more than 10 million automotive-grade wireless modules worldwide.

Research & Development
Given its history as an electronics manufacturing services provider, Flex hasn’t been compelled to make sizeable investments in research and development. Indeed, the entire company spent just $30 million on R&D in FY 2014 and FY 2015, and $75.5 million in FY 2016. That translates to only 0.1% of sales in FY 2014 and FY 2015, and 0.3% of sales in FY 2016. That investment will have to grow significantly with Flex’s current emphasis on original design manufacturing. Bosch, for example, invested 9.1% of sales in R&D in 2015.
Flex Automotive continues to expand its R&D activities. Some projects are already underway, for example to integrate body electronics, and “find ways to up-integrate and slim down the things that are currently in the doors and seats, make them easier to package,” according to Mr. Helfrich. Flex is also exploring ways to integrate switches and displays into the interior. “You are going to start seeing displays much more organically formed into the surfaces of the vehicle. We are being asked to assist with that. Customers want to know what can work in the vehicle.”

Another area of interest Flex is working on with some customers is different ways to identify the driver and monitor for things such as attentiveness and position. Driver monitoring will be an essential component of future piloted driving systems.

Flex is also exploring ways to update the vehicle’s connectivity hardware. The car is a 20 year durable object. Over that period of time cellular communications will move through a few generations. “The architecture of the connected vehicle will have to be modified to account for that,” said Mr. Helfrich.

Given Flex’s experience with dc/dc conversion and energy storage, the company is working on the electrification of pumps and other belt-powered machines, getting power to them and storing power when coasting.

**Electronics Packaging**

The perpetual call for more feature content is being answered with highly integrated electronics. As computing density increases, the demand for improved heat dissipation grows as do the opportunities to locate those electronics in untapped places within the vehicle. Flex specializes in the packaging of electronics—the mechanics of miniaturization and cooling. “Flex has experience manufacturing hyper-miniaturized electronics wearables,” said Mr. Helfrich. “We understand how to mold electronics into plastic and make it come to life with active surfaces. Instead of bolting a box to a door with a wiring harness, we microminiaturize that board and mold it into the plastic with flexible circuits instead of wires. That’s the frontier we are on now.”
Flex Automotive is responding positively to opportunities—for customer engagements, partnerships and acquisitions—within these megatrends, strong growth segments of the OE automotive electronics market.

- Zero Accidents*
- Seamless Connectivity (Flex predicts that by 2025 90% of new vehicles will be connected.)
- Zero Emissions
- Vehicle Electrification
*Includes ADAS and autonomous vehicles

**Acquisitions**

More automotive acquisitions by Flex are coming. Nicole Stevenson, Flextronics vice president of business strategy and marketing, clarified the strategy: “We are interested in companies that fall into those four megatrend categories. We don’t look at anything that needs restructuring or fixing. We look at things that are accretive to margins and revenue, growing and emerging trends, nothing that is going away.”

A good example of Flex’s acquisition strategy is its purchase last year of Mirror Control International, a private company based in the Netherlands, producing active grille shutter and exterior mirror actuators. MCI generated roughly €200 million annually at the time of the acquisition, and had been historically increasing revenue 20% year over year, according to Flex.

**Company Strengths**

What separates Flex from its automotive competition, in Mr. Helfrich’s opinion, is its flexible business model. “We can provide manufacturing services and over time change the relationship to where we provide full system design and development expertise. The one size fits all business model often doesn’t work. Another differentiator is that we can bring in expertise from a broad electronics world: Flex serves 12 different electronics markets, each with over a billion dollars in revenue. We have fundamental
knowledge of the cloud, of consumer electronics, medical electronics, automotive. When I have a question related to connectivity, antenna design, we have experts in the company who have been doing that for 20 years, because they do the wireless routers for the world. Somebody in Flex has the fundamental knowledge of every problem I’m going to run into in our automotive product line, from high-end microprocessors to cooling, to server design, to data abstraction and high volume data manipulation.”

**Wide-Ranging Capabilities: Flex Corporation’s Top Ten Customers and End Products in FY 2016 (listed alphabetically)**

<table>
<thead>
<tr>
<th>Company</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple</td>
<td>Desktop computing, power chargers, and aftermarket services for notebooks, tablets and smart-phones</td>
</tr>
<tr>
<td>Cisco</td>
<td>Core routers and switches, data center, wireless and enterprise telecommunications infrastructure equipment</td>
</tr>
<tr>
<td>Ericsson</td>
<td>Radio base stations for Long Term Evolution and GSM infrastructure, and optical communications equipment</td>
</tr>
<tr>
<td>Fitbit Inc.</td>
<td>Wearable electronics, digital health devices</td>
</tr>
<tr>
<td>Ford Motor Company</td>
<td>In-car connectivity, lighting products, solenoids and motion control electronics</td>
</tr>
<tr>
<td>Hewlett-Packard</td>
<td>Printers, storage devices, and services for computing devices</td>
</tr>
<tr>
<td>Huawei Technologies</td>
<td>Wireless and enterprise telecommunications infrastructure, smartphones and optical communications equipment</td>
</tr>
<tr>
<td>Lenovo/Motorola</td>
<td>Mobile communication devices, wearables and connected living devices</td>
</tr>
<tr>
<td>Microsoft</td>
<td>Gaming, computer peripherals and other consumer electronics devices</td>
</tr>
</tbody>
</table>

**Shareholders’ Equity by Fiscal Year**

<table>
<thead>
<tr>
<th>Year</th>
<th>Equity in $ millions</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>2,284</td>
</tr>
<tr>
<td>2013</td>
<td>2,248</td>
</tr>
<tr>
<td>2014</td>
<td>2,202</td>
</tr>
<tr>
<td>2015</td>
<td>2,396</td>
</tr>
<tr>
<td>2016</td>
<td>2,606</td>
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2012 to 2016 CAGR: 3.4%

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OTA Updates—Carmakers Proceeding Deliberately

The benefits of over the air updates are obvious to everyone. Billions of dollars in warranty costs will be saved. Fewer trips to the dealer will be required. Customers will appreciate new features and upgrades throughout the vehicle’s life. Software glitches will be quietly fixed; recalls avoided. Cybersecurity defenses will be kept up to date.

Smartphones have been receiving OTA software updates for many years. Tesla, which recently activated autonomous driving features OTA, has been routinely updating vehicle software remotely since 2012.

It will take at least another five years for some of the most progressive major carmakers to implement the OTA capability Tesla exhibited in 2012. Tesla had the advantage of very low volume and an EE architecture designed from inception to be remotely updatable.

“Everything they did was fresh,” said Rainer Holve, vice president for connected cars at Elektrobit. “They do most of their software in house, so they have full control over the system. They made an architecture that lends itself easily to being updated over the air. All Teslas are connected; many cars from the traditional carmakers, not yet. The traditional carmakers carry legacy ECUs from model year to model year that simply don’t have the capability to be updated over the air.”

Another difficulty for traditional carmakers is the interoperability issues among the ECUs that talk to each other on the vehicle bus. “Some carmakers already employ a powerful connected gateway. In theory they could do OTA updates, but they shy away from it because they are not sure they won’t break the car in an attempt to update a single ECU,” said Mr. Holve. Elektrobit has been working with a carmaker to integrate OTA capability into its ECUs.

The market for OTA hardware, software and services is at a very early stage. It will grow incrementally as the connected car fleet grows and as more connected cars are equipped to accept updates. Today only 20 million vehicles are connected; by 2020, 100 million cars will be

The Hansen Report on Automotive Electronics, September 2016

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connected, according to Red Bend, the OTA update services and technology provider acquired by, and now a division of, Harman International.

Richard Kinder is vice president of technology at Red Bend. “The first OTA update wave came some years ago with GM’s telematics control unit, part of the OnStar platform. From there it spread to the infotainment domain, and over the coming years it will expand to cover the rest of the vehicle,” he said. Next to be updated will be the least safety-critical domains such as the body control module and the cluster, followed eventually by vehicle control systems including ADAS and autonomous driving systems.

Ultimately, OTA updates will be done where and when they are most convenient for the customer—for most that means at home in the middle of the night. The customer will choose the time and place. For at least the first several years, however, car dealers will be administering OTA updates. Service technicians will verify that the updates are successful. Regardless, it will be hard to cut the dealer out of that business, at least in the United States. In the U.S., National Automotive Dealer Association revenue totaled $862 billion in 2015. Recall and warranty work accounted for approximately 10% of the total. Software updates are accounting for a sizeable and growing share of dealer revenue.

A 2015 IHS Markit report estimates: “Total worldwide OEM cost savings from OTA software update events will grow from $2.7 billion in 2015 (primarily from savings related to updating telematics systems) to more than $35 billion in 2022 (with telematics and infotainment system updates comprising most of the savings).” Egil Juliussen is director and principal analyst for automotive technology at IHS Markit, and one of the report’s co-authors.

Even with dealers handling the updates, Marques McCammon, general manager of Connected Vehicle Solutions at Wind River, thinks carmakers will be able to reap big savings with Wind River’s Helix Chassis OTA update solutions. “A dealer update done in the conventional way will take anywhere from four to six hours to go through the process, plus verification. The conventional update would cost $400 to $500. Instead of re-flashing the entire car, we can do a differential update by isolating only what is different. That would take no longer than an hour and cost about
$100. The OTA re-flash would take place on the dealer’s premises, after which a technician would verify that the update has cleanly taken.” Wind River’s OTA technology came initially from Arynga, which merged with Wind River in April 2016. Wind River is a wholly owned subsidiary of Intel.

While there is plenty of enthusiasm around the industry for OTA updating, not all updates will be done over the air. “There are many, many use cases where this will not be practical, permitted, or safe to do,” cautioned Mark Zachos, who manages engineering and sales for DG Technology, a unit of the Dearborn Group. For example: “Some updates take 12 hours or longer. Or the customer lives in a remote area without a reliable cellular connection. Some safety-related updates may require mechanical intervention or calibration by a skilled technician.”

Standards
As the push for OTA updates has accelerated over the last few years, some standardization initiatives have emerged. OMAuto, a working group within the Open Mobile Alliance, has recently been set up to consider ways to align existing telecom standards with the needs of the auto industry. The group will address the link from the cloud to the vehicle. Wind River is an active participant. Here’s the OMAuto webpage.

OMAuto Incubator Goals
- Establish a venue for discussion between telecom and automotive at a technical and industry level to establish any network, any automobile communication
- Identify select established telecom specifications to optimize for the needs of the automotive market
- Create a path for the automotive industry to interface with the rest of IoT via standardized enablers
- Bridge existing standards with standardization efforts in the automotive sector
- Enable a path for automakers and operators to encourage communications interoperability across automotive and wireless industries
Other standards address the protocols used within the vehicle. “To update individual ECUs from the update master, as an industry we have invested very heavily in UDS, the Universal Diagnostic Services protocol,” said Red Bend’s Mr. Kinder. It gives you a standardized way of saying to an ECU, ‘Here is new software, let me program you.’ It is broadly deployed in the dealerships. Some OEMs have different flavors, but it is a known art.”

DG Technology’s Mr. Zachos, chairman of the SAE Diagnostics Standards Committee and vice chairman of the SAE Vehicle Architecture and Network committee, agrees. “OTA updating should be a natural extension of what happens today at the dealership when they have to re-flash an ECU.”

According to Mr. Zachos, SAE International is pulling together a joint industry group (ground vehicles, aerospace and commercial vehicles) to develop a common definition of a vehicle gateway standard. “In that vehicle gateway device there will be some hardware and software required to do the secure OTA update. Once it gets past the gateway I don’t believe [a standard] is required.” Essentially a set of best practices, the standard would be voluntary.

The industry has embraced the need for OTA updates but will proceed cautiously, keeping vehicle reliability and safety in mind. Mr. Kinder noted, “The biggest obstacles we are seeing is a lack of confidence in the technology and difficulty in adjusting to the concept that vehicle software continues to live after SOP. It’s not a thing you do once. It is something you tend and nurture over some or all the lifetime of the vehicle.”
John Ellis on Software and Threats to the Auto Industry from Google and Apple

John Ellis, a self-described “software guy who works with cars,” was Ford’s top software technologist for nearly three years, during which time he spearheaded the development of SmartDeviceLink (SDL). SDL allows smartphone apps to run on the vehicle’s infotainment system. He left the carmaker in October 2014 and returned to his eight-person consulting practice, Ellis & Associates, which focuses on software and software strategy, among other topics.

Speaking at multiple conferences and, as he says, “to anyone who will listen,” Mr. Ellis has been insisting for years that if carmakers are to survive they need to make software part of their DNA. The industry has largely responded to that message and is vigorously developing real software expertise. “The industry is shifting; it has to. OEMs are coming from a world of ‘ship and forget’ to where they now must be ‘ship and remember,’” he said, meaning a future where they continue to improve the vehicle with updated software after sale.

Over the past decade nearly every major carmaker has opened or expanded research centers in Silicon Valley. The race to develop fully autonomous cars and new mobility services has produced multiple alliances, cooperative ventures, investments and acquisitions among global automakers, technology giants Google and Apple, technology startups and software specialists.

In their upcoming platforms, BMW and Audi are leading the auto industry in adopting service oriented architectures (SOAs) from the IT world for their onboard systems. The rest of the industry has not yet publicly embraced the technology.

“SOA did come up as a topic at Ford, however it wasn’t in the context of how the car’s ECUs would coordinate with each other. It was more in the context of the back end,” Mr. Ellis said. “The problem is, in the automotive industry, the ECUs, the source of services, have never communicated with each other. An ECU from Bosch doesn’t coordinate with an ECU from Delphi. The auto industry doesn’t yet have an open, well-defined standard that can support this.” Work on the new Autosar Adaptive Platform, which will support SOA, has only recently begun.
Mr. Ellis strongly believes carmakers should be able to choose modules from different suppliers that allow for seamless interoperability without requiring customized solutions.

**Google Incursions**
While he advocates for OEMs seeking new technologies and new business models from outside the automotive industry, Mr. Ellis has also for years been urging carmakers to be wary of incursions from the likes of Google and Apple. He thinks their interests clash with carmakers’. Despite Mr. Ellis’s warnings, most carmakers, are providing Android Auto and Car Play links to Android and Apple devices, respectively. Notable exceptions are Toyota and Mazda, who both use SmartDeviceLink to control smartphone apps on their infotainment systems, and to collect their own customer usage data.

For carmakers supporting Android Auto, it’s a very asymmetric relationship in favor of Google, according to Mr. Ellis. Google gets access to a lot of very valuable data. The resulting advertising revenue stream created by using that data flows only to Google. If carmakers owned all the data collected from their connected vehicles, Mr. Ellis pointed out, it could be aggregated in different ways and monetized not just for advertising, but also for things like traffic and weather services, state and local departments of transportation tracking road conditions and maintenance, insurance companies, social media companies, local merchants and more.

In addition to potentially giving up its data, the carmaker has to cover the cost of integrating the Android Auto device linking software into the head unit, as well as the cost associated with testing, validation and verification. And if the Android mobile device experience is anything to go by, the carmaker must also agree to maintain certain minimum hardware requirements, for example the size of the display, its refresh rate, the processor speed and a minimum of cache memory. The carmaker also agrees to update the head unit’s hardware at a certain rate. The carmaker must agree not to distribute any other product that would be debilitating to Android. And further, the carmaker must commit to a minimum penetration of the Android Auto feature in new vehicles, say, 20% or 30% of production.
In return the carmaker gets to advertise that they can accommodate Android Auto apps on the vehicle’s display and drivers can control them with the vehicle’s user interfaces.

Before Android Auto and Apple CarPlay, carmakers were branding their own connected infotainment system solutions, Cadillac Cue, MyFord Touch, Audi Connect, Mercedes mBrace2, Chrysler Uconnect, and Hyundai Blue Link for example. Not tethered to Apple or Google, Toyota plans to continue promoting its Entune branded system.

“At one time there were over 25 connected solutions,” said Mr. Ellis, speaking last June at Mentor Graphics’ IESF Detroit conference. “And what are Google and Apple doing? They are coming in saying, ‘Our UI trumps all of those UIs.’ Next thing you know, all the sub-brands [could] go away and now it’s the Apple Mercedes car or the Google Kia car.”

Looming on the horizon is an automotive-specific version of the new Android N (Nougat) operating system for infotainment systems. Google demonstrated an Android N infotainment system concept in a Maserati at its Google I/O developers’ conference in May 2016. The demo included a 15-inch display screen as well as a full digital instrument cluster. Google also said that the new OS will handle in-car features such as climate control.