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So Many Platforms

There has been a lot of discussion around the topic of whether automotive innovation would benefit from a development platform that is open, robust, extensible and secure. A platform that would do for cars what Windows did for PCs or what Android and iOS did for smartphones. With the right platform, the industry would enable a vast and innovative ecosystem of third-party developers and make the platform developer super-rich. But because carmakers are liable for any safety problems caused by their vehicles, they exert almost total control over what applications can run on them. Carmakers are very protective of their brands and have kept their ecosystems limited.

No platform developer has yet gotten all that rich from the auto industry, not Microsoft with its Windows CE for Automotive software platform, and not QNX, whose software platform runs more than half of the world’s infotainment head units shipped each year. QNX’s strong market position was due in part to its platform’s low price. QNX could keep its prices low because some of the software used in the infotainment platform was developed and paid for by the higher-volume consumer business when the company was part of Harman, and later when its present parent, BlackBerry, was more focused on the consumer market. But QNX didn’t have a way to monetize its strong automotive market position beyond collecting revenue for the QNX Car software platform.

QNX’s share of the infotainment head-unit business has probably peaked in favor of two Linux-based operating system platforms: Android (see our article on Android on page 6) and Automotive Grade Linux. Toyota has been AGL’s chief advocate.

In contrast with QNX, Google has famously demonstrated an ability to build vast scale with its Android software platform, and more importantly, profit from that scale. Google developed Android and gave it away for free to smartphone developers so it could run Google Maps and other apps on a lot of phones. Without Android it would have been too expensive to make different versions of Google Maps for every new phone released by multiple manufacturers. With Google Maps now on every Android phone, Google is able to demonstrate to Google Search advertisers when customers actually went to a place that came up in a search.

Despite a modest history of successful platforms in automotive, almost every week it seems someone is introducing a new software platform to the auto industry. In addition to infotainment system platforms, we are seeing map/location platforms, OTA update platforms, cloud platforms and autonomous
driving platforms. **General Motors** recently introduced OnStar Go, what it is calling, “the industry’s first cognitive mobility platform.”

**Platforms for ADAS and Autonomous Driving**

With the auto industry plowing aggressively into autonomous driving, numerous platforms have emerged. Not only must autonomous driving platforms be open, robust, extensible and secure, they must also be fault tolerant. And they must be able to support the collection, storage and processing of vast amounts of data so the machines can constantly be engaged in learning how to drive autonomously over different kinds of roads in conditions that are always in flux. No autonomous driving platforms are yet Linux-based. Linux is not yet certified for automotive functional safety, although a functional safety expert group was set up within the Automotive Grade Linux project.

“The autonomous driving platform will be a big battleground for dominance,” said Egil Juliussen, director of research and principal automotive technology analyst for **IHS Markit**. “Ultimately we will end up with multiple platforms, because the auto industry won’t allow a single entity to dominate.” Here are some of the leading platform contenders:

**Nvidia**

Nvidia is involved from the vehicle to the cloud with its end-to-end artificial intelligence architecture. Embedded in the vehicle, the Nvidia Drive PX 2 computing platform, already in production, scales from a palm-sized, energy-efficient module suitable for highway automated driving and HD mapping to a supercomputer able to support fully autonomous driving. In October 2016, Nvidia announced that **Tesla** is equipping all its vehicles—the Model S, Model X and the upcoming Model 3—with the Drive PX 2 computing platform. At CES 2017, Nvidia and **Audi** announced they would put a Level 4 autonomous vehicle based on Drive PX 2 on the road by 2020.

In August 2016, Nvidia announced a partnership with **Baidu** to create a cloud-to-car autonomous platform for local Chinese and global carmakers. Baidu is one of the world’s largest Internet companies. Nvidia also has partnerships with map makers **TomTom** and **Zenrin**.

**Bosch** and Nvidia partnered to develop AI self-driving computers based on the Drive PX 2 platform for production cars, with software that integrates Bosch radar and other sensors.

For use in the data center, the Nvidia DGX-1 supercomputer is built for deep learning and AI-accelerated analytics. It comes integrated with hardware, deep learning software and development tools, and runs popular accelerated analytics applications.
The Nvidia DriveWorks software development kit is used for building algorithms for object detection, map localization and path planning.

**QNX**

One year ago, QNX rolled out its software platform for ADAS and automated driving. Called QNX Platform for ADAS, it is built on QNX OS for Safety, which has been certified to ISO 26262 ASIL D. QNX claims a 30-year history with safety critical systems. The ADAS software platform can support applications ranging from 360-degree surround views of the vehicle, to sensor fusion systems and high-performance processors that make control decisions in fully autonomous vehicles.

More than 40 carmakers already use QNX operating systems and middleware in infotainment systems and telematics control units, markets in which QNX presently has a majority share. In October 2016, Blackberry signed an agreement to dedicate a team to work with Ford to expand Ford’s use of QNX’s Neutrino operating system, hypervisor and audio processing software.

An impressive list of companies have partnered with QNX to integrate their technology with the QNX Platform for ADAS.

- **Intel**  Atom processor C2000 family
- **Texas Instruments**  TDA2x processor family, vision library
- **Renesas**  R-Car H3-based autonomous driving development platform
- **Nvidia**  Drive computing platform
- **Itseez (acquired by Intel)**  Vision processing algorithms
- **Cohda Wireless**  V2X boards and software

**BMW, Intel and Mobileye**

In July 2016, these three companies partnered to create an open, standards-based, end-to-end platform for autonomous driving. The platform, which will have deep-learning capabilities, will be made available to multiple carmakers.

While latecomers to automated driving platform development, these three high-powered companies could spark a formidable automated driving ecosystem. **BMW** is a technology pioneer, well versed in the promise of automated driving and the provision of mobility services. **Intel**, with its estimable microprocessor platforms, communications hardware and mission-critical software platform expertise from **Wind River**, has over the last two years established itself as a promising tier-two automotive supplier ready to support autonomous driving applications from the car to the cloud. **Mobileye**, the dominant provider of camera-based image processing technology, aims to also be a leading provider of the high-
definition maps and sensor fusion technology crucial to ADAS and automated driving.

**Renesas**

Renesas, the world’s number-one supplier of automotive microcontrollers, will soon offer an open development platform that provides a framework for an ecosystem to fill out the offering. Not limited to autonomous driving, the prototype development platform will also be open to developers of cockpits, HUDs and driver monitors. “It’s a place where even our tier-one customers can work with each other,” said Amrit Vivekanand, vice president of Renesas’ North American automotive business. The platform effort will be joined by QNX. Polysync will provide its sensor fusion API.

**Apple**

According to reports, Apple has moved its automotive focus away from building a self-driving electric car to concentrate on developing an automotive operating system and a software platform for autonomous driving. According to Bloomberg News, Apple’s team in Canada includes two dozen former BlackBerry QNX engineers who are working on the operating system. A separate team is developing the software that will guide future self-driving vehicles and will run on the new automotive OS. The OS team is headed by Dan Dodge, QNX’s founder and former CEO, who joined Apple in early 2016. The Apple development center is located not far from QNX headquarters in Kanata, a suburb of Ottawa. Apple’s software platform will be offered to carmakers.

**Waymo**

Alphabet’s self-driving car unit, Waymo LLC, wants to market an autonomous car platform that bundles software along with in-house developed hardware including 360-degree radar, eight vision modules and two lidar sensors. Waymo demonstrated the platform running a self-driving Chrysler Pacifica at the Detroit auto show.

Numerous other companies are offering autonomous driving software platforms including Elektrobit, NXP, Visteon, Green Hills Software, and Mobileye together with Delphi. ◆
The interest in Android built to run natively on infotainment head units has been building. “Since we first announced and showed this at Google I/O in May 2016, we have been flooded with the traction Android is getting in the automotive space,” said Patrick Brady, who directs Android development projects for the auto industry at Google. “We have a lot of carmakers who are choosing to ship Android on their next-gen infotainment systems.”

Built for automotive, the platform is based on Android N (Nougat), the latest version of the operating system employed in multiple end markets, primarily smartphones. The automotive platform features user interface elements that make sense for the car. It includes middleware and subsystems for controlling AM/FM radio, HVAC, Bluetooth calling and media streaming, multi-channel audio, and digital instrument clusters. “Traditionally these were things that had to be custom built for every car by the tier-one supplier, and now this comes for free as part of open source Android,” said Mr. Brady.

The vast majority of the functionality of Android Nougat for automotive, for example platform support for radio, Bluetooth, HVAC and vehicle network integration, is available in open source today. No agreement with Google is necessary. “The carmaker gets a full stack platform for infotainment, everything from applications and user interface down to the kernel, optimized and proven for automotive,” noted Mr. Brady. Carmakers that choose to ship Google services such as Google Maps, Google Play Music and Google Assistant, have to sign distribution agreements.

Additional features will become available in future Android releases as they hit open source. Developers who want to base their applications on the next version of Android, Android O, must sign a pre-development agreement. Android O is due for release in 2017.

Because carmakers can get 80% or 90% of the software needed to build a solution through open source, the Android platform allows carmakers to bring new infotainment systems to market more quickly, at less cost.
They can spend their time adding features or user experiences that are unique to their brands, without having to build and test a new Bluetooth or HVAC stack over and over again. Further, carmakers get a modern software platform with a rich set of subsystems that are built for connectivity. Nearly every major automotive semiconductor supplier is already up and running on Android.

**Correcting Some Untruths about Android Built for Automotive**

One of the arguments I continue to hear against running Android natively on the head unit is that carmakers will not be permitted to have their branded look and feel. This is no longer an issue. The Chrysler demonstrations at CES 2017 definitely looked like Uconnect, not the Google or Android user interface.

Another argument against Android is that Google dictates which applications and services carmakers can use. This is also untrue. The Uconnect demonstrations featured Spotify and Pandora along with Google Play for music. It also featured NPR One and the popular podcast application Pocket Casts.

According to Mr. Brady, Google is motivated to create a consistent platform for software providers. Not only does Google benefit, but Pandora, Spotify, iHeart Radio and Facebook also benefit by having a consistent platform across multiple end products, from tablets and smartphones to wearables, televisions and cars. “What we are looking for here is really to make Android the best possible choice as an infotainment platform. It will give carmakers a lot more freedom to integrate whatever media streaming, navigation or other services consumers want. Over the last ten years the auto industry has been focused too much on integration at the expense of innovation.”

Another misconception about Android running natively on the head unit is that Google wants data from cars, and that Google and not the carmaker will be able to access and profit from the car’s data. Now that Google has worked on more than 50 projects with carmakers over the last two-plus years, the industry is less wary, according to Mr. Brady.

“Google has no ulterior motive to collect massive amounts of data. We are not pushing ads; we are not trying to monetize this. Google has been working with carmakers since 2005. All that time we’ve been working to get our applications integrated into cars, not data out of cars. We worked with Audi
and Volkswagen to get Google Earth into their cars. We had to port Google Earth to a proprietary version of QNX. It took us years to do that. We worked with several carmakers to get Local Search APIs integrated into their vehicles. It’s complex to do. We have to port our applications to a proprietary platform, support them for many years, and then when we have a new version of our app available, we can’t get it into those cars.”

At CES this month, Chrysler and Qualcomm each featured in their booths proof of concept demonstrations of what will likely be Chrysler’s next-generation Uconnect infotainment system.

Chrysler’s Next Generation Uconnect
The Uconnect system demo was impressive. Google Maps responded instantly to pinch, zoom and tilt gestures. The system was contextually very aware. When Google was asked, “How tall is Las Vegas’ Stratosphere Tower,” and then asked for directions, the navigation system knew the speaker wanted directions to the Stratosphere Tower. Google Assistant was also part of the demo.

According to the Qualcomm engineer who worked on the Uconnect demo, the project to integrate the Snapdragon 820A processor with the Android platform took approximately four months. It went quickly because of Qualcomm’s deep experience with Android smartphones. The Galaxy S7 also employs the Snapdragon 820 processor. A major benefit of using Android, according to this engineer, is the large app-development community. “Any third-party application already able to run on Android smartphones or tablets can be quickly ported to the Android automotive platform.”

While Chrysler has not gone through the quote process with Google, chances are quite good that the Android platform will underpin Chrysler’s fifth-generation Uconnect system when production for it starts in 2019 or 2020. Generation-four Uconnect was introduced in 2016. Chrysler has been on a three- or four-year cycle with Uconnect.

Audi engineers I spoke with at CES told me they will soon bring an IVI system to market that employs the Android platform to run applications.
The IVI applications will be kept separate from the cluster running on a QNX platform.

**No Android for ADAS and Autonomous Driving**

While the Android platform does support infotainment information displayed on the cluster, it does not support speed and tach displays or tire pressure alerts. “You need a safety-critical, real time OS for those things,” said Mr. Brady. “Linux is not a real time system; it is a best effort system. You don’t want it operating safety-critical things.”

Android will not be the operating system that supports autonomous driving systems for Waymo, formerly known as Google’s self-driving car effort. ◆
The Company Profile: Hitachi Automotive Systems

**Thumbnail Sketch**

*FY 2015 ended on March 31, 2016.*

**Hitachi Automotive Systems**
- **Headquarters:** Tokyo, Japan; [www.hitachi-automotive.co.jp](http://www.hitachi-automotive.co.jp)
- **FY 2015 Revenue:** ¥1,001.1 billion ($8.6 billion)
- **R&D Expenses:** 7.0% of revenue
- **Capital Investment:** 7.2% of revenue
- **EBIT Margin:** 5.4%
- **Operating Cash Flow:** ¥89.4 billion ($764 million)
- **Employees:** 33,214
- **Revenue per Employee:** ¥30.1 million ($258,000)
- **Top Customer:** Renault-Nissan
- **Major Products:** Engine management systems, electric powertrain systems, drive control systems, car information systems

**Hitachi Ltd.**
- **FY 2015 Revenue:** ¥10,034.3 billion ($85.8 billion)
- **R&D:** 3.3% of revenue
- **Interest Charges:** 0.3% of revenue
- **EBIT Margin:** 5.3%
- **Net Cash Provided by Operating Activities:** ¥812.2 billion ($6.9 billion)
- **Working Capital:** ¥878.3 billion* ($7.5 billion)
- **Total Equity:** ¥4.13 trillion* (as of Dec. 27, 2016)
- **Employees:** 335,244*
- **Revenue per Employee:** ¥29.9 million ($256,000)

*As of March 31, 2016

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### Hitachi Automotive Systems Revenue and EBIT Margins, by Fiscal Year

FY 2011 to FY 2015 CAGR of Revenue: 5.4%
FY 2015 to FY 2018 CAGR of Revenue: 3.2%

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>Revenue (in ¥ billions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY 2011</td>
<td>811.5</td>
</tr>
<tr>
<td>FY 2012</td>
<td>806.8</td>
</tr>
<tr>
<td>FY 2013</td>
<td>892.4</td>
</tr>
<tr>
<td>FY 2014</td>
<td>936.9</td>
</tr>
<tr>
<td>FY 2015</td>
<td>1,001.1</td>
</tr>
<tr>
<td>FY 2016</td>
<td>970.0*</td>
</tr>
<tr>
<td>FY 2018**</td>
<td>1,100**</td>
</tr>
</tbody>
</table>

**EBIT Margins**

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>EBIT Margin</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>4.6%</td>
</tr>
<tr>
<td>2012</td>
<td>4.4%</td>
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<tr>
<td>2013</td>
<td>0.4%</td>
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<td>2014</td>
<td>3.7%</td>
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<tr>
<td>2015</td>
<td>5.4%</td>
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<tr>
<td>2016*</td>
<td>5.7%</td>
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<tr>
<td>2018**</td>
<td>6.9%</td>
</tr>
</tbody>
</table>

*Forecast  **Target

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### Hitachi Ltd. FY 2015 Revenue and EBIT Margins, by Segment

<table>
<thead>
<tr>
<th>Segment</th>
<th>Revenue ¥ Billions</th>
<th>EBIT Margin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information &amp; Telecommunications Systems</td>
<td>2,109.3</td>
<td>5.2%</td>
</tr>
<tr>
<td>Social Infrastructure &amp; Industrial Systems</td>
<td>2,333.1</td>
<td>1.2%</td>
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<tr>
<td>Electronic Systems &amp; Equipment</td>
<td>1,127.6</td>
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<tr>
<td>Construction Machinery</td>
<td>758.3</td>
<td>3.4%</td>
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<tr>
<td>High Functional Materials &amp; Components</td>
<td>1,564.0</td>
<td>9.8%</td>
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<tr>
<td><strong>Automotive Systems</strong></td>
<td><strong>1,001.1</strong></td>
<td><strong>5.4%</strong></td>
</tr>
<tr>
<td>Smart Life &amp; Ecofriendly Systems</td>
<td>681.0</td>
<td>6.2%</td>
</tr>
<tr>
<td>Others (Logistics and Other services)</td>
<td>1,252.7</td>
<td>3.2%</td>
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<tr>
<td>Financial Services</td>
<td>365.3</td>
<td>12.8%</td>
</tr>
<tr>
<td>Subtotal</td>
<td>11,192.7</td>
<td>5.0</td>
</tr>
<tr>
<td>Corporate Items &amp;Eliminations</td>
<td>(1,158.4)</td>
<td>–</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>10,034.3</strong></td>
<td><strong>5.3%</strong></td>
</tr>
</tbody>
</table>

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[www.hansenreport.com](http://www.hansenreport.com)
Introduction

Hitachi Automotive Systems (HAS) is one of nine reporting business segments that comprise the $86 billion Hitachi Ltd. HAS accounted for 10% of total sales in the 2015 fiscal year. Within the Hitachi Automotive Systems Group are 63 companies that operate 136 facilities globally, including in Japan, North, Central and South America, Europe, China and elsewhere in Asia.

The automotive business supplies a diverse range of technologies and products which, according to the company, demonstrates its focus on the environment, safety and information.

Hitachi’s products that address the demand for better fuel economy and lower CO2 emissions include engine management systems, electric motors, inverters and lithium-ion batteries for hybrid vehicles. For safety, Hitachi supplies products such as semi-active suspension systems, braking systems and advanced driver assistance systems. In the information product area, Hitachi supplies multifunction vehicle information systems that work with cloud-based network services to provide easy access to content such as video, music and news, as well as map updating services. They also include car navigation systems with natural speech interfaces.

In the 2015 fiscal year, 60% of Hitachi Automotive Systems’ revenue came from overseas markets.

Like other international tier-one suppliers, Hitachi has decided to make English its main language for communication both internally and to the outside. Internal communications in English will begin in 2018.

Background

Hitachi first delivered automotive parts in 1936, to Toyota and Nissan, but the Automotive Products Division was not formally established until the mid-1960s, with its main Sawa Works production facility located in the Ibaraki prefecture. Production
outside Japan began in the 1980s with the opening of Hitachi Automotive Products USA in Kentucky, and a technical center in Farmington Hills, Michigan.

Hitachi expanded its automotive business in the early 2000s through acquisitions, notably Xanavi Informatics, a former Hitachi-Nissan joint venture for navigation and telematics, and Unisia JECS, in which it had an equity position, as did Nissan and Bosch. In 2004, Hitachi merged its subsidiary Tokico with Unisia and Hitachi Automotive Products, creating the new Hitachi Automotive Systems.

Clarion was acquired by the Hitachi Group in December 2006. One month later, Xanavi became a 100% Clarion subsidiary, and the two companies merged completely in 2009. (For more, see the company profile of Clarion in the June 2016 Hansen Report.)

According to Paul Carroll, president and CEO of Hitachi Automotive Systems Americas, Kunihiko Ohnuma, chairman of the board of Hitachi Automotive Systems Ltd., was a main driver in the merging of Hitachi, Tokico and Unisia. “Mr. Ohnuma had a very tough job to bring those three companies under one umbrella,” he said. “Hitachi Automotive Products’ focus was on electronics and powertrain products. Unisia was primarily focused on engine and some powertrain and steering products. Tokico was chassis. Since Mr. Ohnuma established Automotive Systems, sales have grown year over year. He established manufacturing facilities all over the world, including new plants in India. He set up 13 plants in China, plus multiple plants in Mexico, the U.S. and Europe.”

Mr. Carroll worked for braking and suspension maker Tokico, which was later acquired by Hitachi. He served as head of sales for Hitachi Automotive Systems America and was named president in April 2016, the first non-Japanese person to hold that title.
Distinctions Claimed by Hitachi Automotive Systems

- Produced the world’s first central engine control units in 1979
- Produced the world’s first photoelectric crank-angle sensor in 1980
- Produced the world’s first semiconductor pressure sensor in 1980
- Motors and controllers from Hitachi were part of the first electric cars (from Nissan) produced for the Japanese market.
- HAS and Airbiquity implemented the first commercial production of globally connected vehicle solutions for the Nissan Leaf EV.
- Mass produced the world’s first electric-power 4WD system, in 2002

Global Market Share in FY Ending March 2015

- Airflow sensors: top share with 40%
- Valve timing controls: the 2nd biggest share with 15%
- Ignition coils: the 2nd biggest share with 13%
- Stereo cameras: top share with 75%
- Suspension systems: the 3rd biggest share with 10%

Source: Marklines.com

Product Strategy

In a presentation to investors made in June 2016, Hitachi Automotive Systems Ltd. president and CEO, Hideaki Seki, said the company’s product strategy aims to “expand the electronically controlled and electrically driven products business and promote systemization in this high growth market [for] more efficient internal combustion engines, electrically driven products [and] enhanced safety performance.”

Growth will come from vertically integrating mainstay products from different divisions, for example expanding the adoption of stereo cameras as part of ADAS systems, and increasing sales of electronically controlled brakes and steering systems that enable autonomous driving features.

Hitachi sees the share of electronics components in the typical vehicle bill of materials increasing from 40% in 2015 to more than 50% in 2018. It hopes to increase the share of electronics products in its own portfolio to 56% in 2018.

HAS’s Powertrain and Electronic Control Systems division and Engine and Chassis division together account for half of total sales. Forty percent of the Powertrain and Electronic Controls division revenue comes from engine control units, automatic transmission control units and ignition coils. Variable valves and steering products drive approximately 50% of revenue in the Engine
Controls division. In the near term, looking out to 2018, HAS expects revenue growth from those core products in the range of 30% to 35%.

“The strength of the company is in our engine control units,” said Mr. Carroll. “Our electronic controls capability—our hardware and software engineers, our manufacturing teams and our commitment to quality—together with our ability to deliver product at a competitive price underlie our success in this market.”

Increased Vehicle Electrification
Hitachi has been supplying powertrain parts and systems for hybrid electric vehicles for more than a decade. “We were really early into the game in electrified vehicles in Japan, with both Nissan and Isuzu,” said John Nunneley, senior vice president of design engineering at Hitachi Automotive Systems. “We were one of the earliest providers for GM here on their Yukon hybrid and Saturn Vue belted alternator starter system.” Mr. Nunneley, who has been with Hitachi for more than 25 years, initially worked on throttle control and electrification systems. In 2012 he took a four-year assignment in Japan, where he worked on brake systems at Atsugi Works and engine control systems at Sawa Works.

The company sees significant growth potential, especially for its motors and inverters, in the continued electrification of vehicles as carmakers are forced to comply with stricter emissions regulations. HAS expects to see revenue growth from motors and inverters approaching 200% by 2018 compared with revenue in 2015.

<table>
<thead>
<tr>
<th>Hitachi Automotive Systems</th>
<th>Major Products</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Powertrain &amp; Electronic Control Systems Division</strong></td>
<td><strong>Engine &amp; Chassis Division</strong></td>
</tr>
<tr>
<td>Motors</td>
<td>Electric power steering systems</td>
</tr>
<tr>
<td>Inverters</td>
<td>Pistons</td>
</tr>
<tr>
<td>Control units</td>
<td>Variable valve timing systems</td>
</tr>
<tr>
<td>Stereo cameras</td>
<td>Variable valve event and lift</td>
</tr>
<tr>
<td>ADAS ECUs</td>
<td><strong>Safety &amp; Information Systems</strong></td>
</tr>
<tr>
<td><strong>Drive Control Systems Division</strong></td>
<td>Autonomous driving ECUs*</td>
</tr>
<tr>
<td>Electrically driven intelligent brakes</td>
<td>Automatic parking systems*</td>
</tr>
<tr>
<td>Semi-active suspensions</td>
<td>OTA Update Solution*</td>
</tr>
<tr>
<td>Hydrogen dispensers</td>
<td><strong>Aftermarket Division/Other</strong></td>
</tr>
<tr>
<td><strong>Car Information Systems (Clarion)</strong></td>
<td>Suspensions</td>
</tr>
<tr>
<td>Telematics communications units</td>
<td>Brake pads</td>
</tr>
<tr>
<td>Voice recognition navigation systems</td>
<td>Lithium-Ion batteries</td>
</tr>
<tr>
<td>SurroundEye camera systems</td>
<td>*Not yet commercialized</td>
</tr>
</tbody>
</table>

www.hansenreport.com
Between 2021 and 2025, Hitachi Automotive Systems Americas expects the strongest impact on sales of electrification products to kick in, with total revenue for North America reaching nearly $5 billion in 2025, more than double FY 2015 revenue.

According to Mr. Carroll, Hitachi has an advantage, not only because it can leverage its strength in controls, but also because it can supply the complete electric drive systems including battery controller and battery cells.

Hitachi Automotive Systems has won orders with three OEMs in North America for electrification products, which could potentially result in billions of dollars in revenue over the next ten years. One is for a complete electric drive system, the other two for components. Some of the new wins are for motors only, some are for inverters, some are for batteries only. Hitachi’s traction motors have been used by General Motors in the Volt.

Mr. Carroll is cautiously optimistic that even if the incoming Trump administration rolls back CAFÉ requirements for the U.S., carmakers will continue to develop electrified powertrains. Most of the major global OEMs have committed to further investments in electric vehicles. Nissan-Renault, Hitachi’s largest automotive customer, has been a strong promoter. “But,” he cautioned, “if the marketplace still doesn’t want to accept electrified power-trains, I’m going to have some factories that are large and empty. We need the regulations because that will drive the carmakers to do things that maybe are a little against the marketplace.”

◆ Compact Inverter
Hitachi’s third-generation inverter, chosen by Daimler in 2014 for its first plug-in hybrid vehicle, offers a 40% increase in power output compared with the prior generation, in a 40% smaller size package. Heat dissipation is improved through the use of a double-sided, water-cooled power module. The third-generation inverter features a power density of 35 kW/L.

◆ 48V Battery
Earlier this year HAS announced it had developed a high-output, 48-volt lithium-ion battery pack for mild hybrid vehicles. Sample shipments began in the summer, and full-scale production is scheduled to begin in fiscal 2018. Hitachi Vehicle Energy Ltd. will handle the manufacturing. The battery pack includes 12 high-output prismatic lithium-ion cells, the battery management system board, relay and fuse.

The high cost of 48-volt components has throttled widespread adoption of 48-volt systems beyond premium features such as electronically controlled suspensions and electric turbocharging. Hitachi expects that as costs come down
and stricter emissions requirements come into play, the business case will become stronger for using 48-volt systems to improve fuel economy.

**Autonomous Driving**
At the start of the 2016 fiscal year, Hitachi Automotive Systems Ltd. established a new division, Safety & Information Systems, to support further development and commercialization of automated and autonomous driving technologies. The new HAS division, with an initial staff of roughly 200, will leverage technologies and expertise from Clarion and from other Hitachi Group segments.

**◆ Autonomous Driving ECU**
In December 2016, Hitachi released details of a new autonomous driving ECU that enables 11 ADAS functions. Prototypes of the ECU are undergoing testing now, and sales are expected to begin in July 2017. The latest autonomous driving ECU adds functionality not available in Hitachi’s previous generation ECU, namely, low-speed traffic-jam assist, low-speed car passing, driver-triggered auto lane changing (activated by using the turn signal) and automatic lane changing.

Hitachi Automotive cooperates with Hitachi Solutions Ltd. in developing autonomous driving ECUs.

**◆ Automatic Parking System**
Hitachi and its subsidiary Clarion jointly developed an automatic parking system that can execute both parallel and perpendicular parking and can bring the vehicle to and from a spot in a parking garage remotely, using a smartphone. The system uses four Clarion SurroundEye cameras combined with Hitachi Automotive’s engine, steering and brake controllers. The automatic system incorporates obstacle and pedestrian detection and the vehicle can be remotely stopped at any time by the smartphone controls.

**◆ Over-the-Air Software Update Solution**
Working with Hitachi Ltd. and Clarion, HAS developed its OTA Software Update Solution, which will provide high-speed, secure delivery of ECU software updates for vehicle security and to enable new functions as they become available. Because all the required technologies are resident within the Hitachi Group, the company can offer customers a complete solution.

The OTA solution includes a data center that generates and distributes the updates and in-vehicle hardware and software. According to Hitachi’s press release, “Hitachi Automotive Systems developed a vehicle system which has a central gateway equipped with OTA software update control and security functions with Clarion’s TCU (telematics communication unit).” The OTA data center extracts and encrypts the differential between the old and new software and delivers only
the differential data to the vehicle. Hitachi expects to be able to begin shipping the product in 2018.

◆ Stereo Camera
Stereo cameras calculate the distance to an object using reference points captured by two cameras, mounted left and right, and the principle of triangulation. Stereo camera systems can detect objects and pedestrians, the road area the vehicle is physically able to drive on, and even distant vehicles.

Hitachi Automotive Systems’ newest generation compact stereo camera requires only about half the distance between the left and right cameras as the previous models, allowing for installation in even compact vehicles. To compensate for the shortened distance between the left and right cameras, Hitachi developed a new process to maintain accuracy in distant-vehicle detection. Together, object detection, drivable road area detection, and enhanced distant-vehicle detection enable automatic emergency braking and front-vehicle-following functions in a compact package. Denso offers a similar compact stereo camera system on the Daihatsu Tanto released in November 2016.

Hitachi supplies the popular EyeSight windshield-mounted CCD camera system launched by Subaru in Japan in 2010 and in the U.S. in 2012.

R&D
The largest R&D expense for Hitachi Automotive Systems has been in the areas of autonomous driving and vehicle electrification. HAS is able to draw on resources from other divisions, including Hitachi’s large IT group and the social infrastructure group in areas such as V2X. Automotive software divisions are being established at other Hitachi Group software companies.

Hitachi is working on pilot research to expand its automated driving capability beyond highways to include small local roadways, a difficult challenge. It is also applying its proprietary artificial intelligence technology to solving the problem of auto-piloted vehicles merging into heavy traffic on freeways. The company says it is currently

<table>
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<th>End Customers</th>
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<tr>
<td>#1 Renault-Nissan, 32% of sales</td>
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<tr>
<td>Others listed alphabetically</td>
</tr>
<tr>
<td>Daihatsu Motor</td>
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<td>Fiat Chrysler</td>
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<td>Ford</td>
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<td>Fuji Heavy Industries</td>
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<td>Mitsubishi Fuso Truck and Bus</td>
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<td>Volkswagen/Audi</td>
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testing the technology and collecting driving data from vehicle merge operations.

R&D spending in FY 2018 is expected to reach ¥110 billion ($940 million), a 57% increase over R&D investment in FY 2015. Hitachi Automotive Systems opened a Silicon Valley office in 2016 to strengthen its software development capability.

**Expand Customer Base**

Renault-Nissan, HAS’s largest customer, accounted for 32% of revenue. Hitachi is working to diversify its customer base by leveraging its global footprint and adding personnel to its global sales teams.

Sales in North America are on the rise, notably with Ford’s and GM’s electrification programs. For example, sales to Ford will triple from FY 2008 levels to ¥100 billion ($855 million) in FY 2018. Because engineering resources in Japan are limited in the current economic climate, Hitachi is hiring as many engineers in North America as it can to serve its growing business with the Detroit Three. Sales in the Americas are forecast to grow by 3.8% annually from FY 2015 to FY 2018.

Hitachi is also looking to China for future sales growth, in the range of 15% per year through FY 2018. ◆
KPMG on Deep Learning

“Deep learning will revolutionize the nature of doing business for automakers. So much so that unless those in the automotive space react wisely to the effect of deep learning, they may be out of business.” That bold statement is from an illuminating white paper by the audit, tax and advisory firm KPMG titled, “I see. I think. I drive. (I learn).” As KPMG sees it, deep learning is the driving force behind autonomous vehicles. “The ability to own the “secret sauce”—the deep learning databases, algorithms, software, and revenue streams—will play a large part in determining the future balance of power.”

Excerpts from KPMG’s 43-page white paper follow.

What Is Deep Learning?
Deep learning is a high performance, dynamic way of computerized decision-making that can learn features, objects, and patterns automatically and more accurately with the more data you give it. A deep learning system identifies and classifies patterns utilizing a set of analytical layers. … Deep learning is a critical enabler of the self-driving vision because it helps software engineers build a vehicle that can essentially think without human intervention.

When?
Deep learning autonomy is nearly upon us. Tesla has announced it is bringing a deep learning-enabled vehicle to market now. It will be continuously improved through software updates to ultimately achieve full autonomy. … Most major automakers are developing production autonomous vehicles with committed on-sale dates in the 2020 or 2021 model year. Initially those vehicles will be geofenced—restricted to “simpler” environments, such as very well mapped urban areas or “lower-distraction” highway and suburban environments.

Deep Learning Experience
When Apple’s Siri or Microsoft’s Cortana understand and respond to your question, that is due to deep learning. … When your Google search almost instantly turns up the exact Web result, that is also due to deep learning. And when Amazon recommends the perfect product, you can thank deep learning. [Deep learning is what powers Mobileye’s computer vision system.]

Data Is Paramount
With deep learning, miles are like gold. Each mile of “eventful driving” is valuable. The input training data gathered from different traffic, different
speeds, different environments, different dangers encountered, and all other
distinguishing phenomena while driving is critical for the ability of deep learning to
build autonomous capacity. … Deep learning unlocks the value proposition for vehicle
and simulated miles, and sparks a competition for them. Their acquisition and the
efficient means for capturing and building knowledge from them will be critical to the
progress of autonomy.

**Fierce Competition for Specialized Talent**
Traditional automakers always owned the “secret sauce” of the vehicle. But with deep
learning, somebody else has it. … KPMG research in June 2016 revealed that the pool
of deep learning specialists is limited, and very few companies have reached critical
scale, e.g., only 28 companies or universities had 10 or more specialists, and that six
technology companies employed 54% of them, i.e., Google, Microsoft, Nvidia, IBM,
Intel and Samsung. Among the others, Qualcomm had 69 deep learning specialists,
Apple, 67, and Ford, 15.

**Computing Headroom a Requirement**
Traditionally vehicle program development has put a primary emphasis on one or two
of a select number of options—styling, packaging, powertrain, or chassis and
suspension—in order to create an attractive, differentiated vehicle. Then it has
relentlessly managed cost, weight, and fuel economy at start of production, relentlessly
pruning any surplus gram or penny from the bill of materials. Now that deep learning is becoming an essential part of the autonomous vehicle, that will no longer be the way of making competitive cars.

Instead, car manufacturers will have to consciously create “surplus” capacity in vehicles’ sensing, computing and communication systems to meet the inevitable demands of future over-the-air updates to their driving programs. That is a profound change in the traditional program management model of minimizing costs, weight or any other form of “surplus” from the design.

**Fewer, Significantly More Expensive Vehicles Will Be Produced Each Year**
A future world of autonomous mobility will require fewer cars per mile traveled. Self-driving cars used for mobility services will drive many more miles than personally owned vehicles and have the potential to replace four individually owned cars. ◆