Embedded Software Sourced Separately From Hardware

From Infotainment to Driver Assistance

Increasingly, as automotive software has grown in complexity and importance, it is being developed by specialists and sold separately from the ECU where it will run. This separation trend began modestly with infotainment more than a decade ago, with companies like Elektrobit providing navigation software and Nuance offering speech software. Today the trend is picking up speed in infotainment and will accelerate as more complex driver assistance systems proliferate.

“The traditional infotainment tier ones used to do everything. They’d provide turn-key black boxes with both hardware and software in them,” said Andrew Patterson, Mentor Graphics’ business development director for the Embedded Software division. “But as software content increased, development costs rose proportionally, to the point where the OEMs said stop.”

Mr. Patterson expanded on the difficulties faced by infotainment systems tier ones. He noted that creating a robust software platform and keeping it up to date requires a massive investment in terms of expertise, working with open source community sites, introducing software management processes, understanding the licensing issues and integrating a long list of user applications. “Each [infotainment] tier one is different regarding how deeply it wants to get involved with software. Some are quick to outsource the software; others keep a large percentage of the activity in house.”

A new class of tier-one software providers like Mentor Graphics is emerging. Mr. Patterson does not see these new software tier ones in direct competition with the traditional full-system tier ones. “The traditional tier one still manages the tasks of full-system integration, testing, validation, and high volume bankrolling, while the

Turn to Software, page 3

U.S. Carmakers Relatively Slow to Adopt ISO 26262

People who have attended ISO 26262 workshops in Europe report far more intensity, interest and knowledge among European participants compared with their U.S. counterparts. According to these and other sources, the Detroit Three appear to be embracing the automotive electronics functional safety standard but at a slower pace, especially slower than the German carmakers who brought it into being.

Work on the standard began in 2004 as a German and French initiative. Early champions included representatives of BMW, Daimler, Volkswagen and PSA. ISO 26262 is an automotive specific standard derived from IEC 61508, a general safety standard covering electrical and electronics equipment used in no particular industry.

By going slowly the Detroit Three risk being seen as deficient when compared with carmakers who have already adopted the standard. ISO 26262 represents the state of the art in safety engineering. Non-compliance makes them vulnerable in lawsuits resulting from crashes where the plaintiff is asserting negligence by the carmaker in the way the vehicle was engineered.

Every region of the world will almost certainly adopt ISO 26262 eventually, but each region seems to have its own pace. European OEMs and tier ones who serve European markets have been among the early adopters. The Japanese OEMs are moving toward adopting the standard, but they are not as far along in the process as the Europeans. According to TRW’s chief engineer of systems safety, Joe Miller, who has been involved with the standard almost from the beginning of its development, “Chinese carmakers are a couple of years behind the Germans in formally taking on ISO 26262, and they will probably take longer than the U.S. OEMs. That is why CATARC [the Chinese Automotive Technology and Research Center] is so aggressive in learning all they can about it. They have partially completed translating the standard into Chinese and plan to provide guidance to Chinese carmakers on how to apply the standard.”

Wensi Jin, automotive industry manager for Mathworks, sees an additional driver for ISO 26262, beyond companies wanting to serve European OEMs. “We are seeing a secondary motivation in the emerging markets especially. These are the companies who are starting to bring more embedded software development in house. They tend to look at the standard as a reference for their own process development,” he said.

Carmakers who are taking it slow with ISO 26262 are certainly relying on engineering practices in which they are confident. They could be rigorously applying the practices outlined in IEC 61508 and software development methodologies such as SPICE or CMMI. They could be waiting to learn from other carmakers’ adoption experiences, or they might be waiting for a newer version of the standard to be released. But a plaintiff’s attorney could reasonably ask a carmaker, “ISO 26262 has been released and applied by others, why haven’t you applied it?”

Being less exposed to a product liability lawsuit isn’t the only reason to aggressively adopt the standard. Conforming to the practices outlined in ISO 26262 will almost certainly reduce the probability that a carmaker will be forced into an expensive safety recall because of a problem with the electronics or software.

“Applying the standard is primarily good systems engineering. It forces engineers to identify the safety requirements and trace them through the design so there is evidence of verification and validation at the end,” explained Mr. Miller, who teaches a course on the subject for SAE internationally.

Christof Ebert is managing director of Vector Consulting Services, which has worked with OEMs and tier ones globally

Turn to ISO 26262, page 2
ISO 26262...

Continued from page 1

to implement functional safety standards in E/E development. Dr. Ebert offered this advice to companies who are tackling the standard: "First, it helps a lot if you already have proficiency from defined, consistent processes. Independent of whether it is SPICE or CMMI and independent of maturity level, if your culture is process minded, the introduction of ISO 26262 is much easier. Second, companies are particularly vulnerable when there are misunderstandings within the supply chain. ISO 26262 provides extremely useful guidance on setting up the development interface between customer and supplier very early in the process. And finally, consistent tool support helps a lot in reducing overhead related to the standard. For example, when there is a change in the specification and you have to release some document again, a product life cycle tool chain like PREVision lets you do that in a minute, compared to the long effort required if you have tools that are not connected."

While there is wide consensus globally that ISO 26262 is the way to go, implementing it leaves much to interpretation. "There is not a lot of common ground on how to use the standard," said Gunther Heling, director of the embedded software product line at Vector Informatik. "When we ask carmakers and suppliers who have applied the standard how much additional effort their safety-related development project took, compared with a non-safety development project, we get answers ranging widely, from an additional 20% to as high as 10 times the effort. Some organizations overdo it; some may not do enough."

Carmakers who are less aggressive in adopting the standard are weighing the potential cost of noncompliance against the considerable investment that conforming to ISO 26262 requires. "The new standard is much bigger than its predecessors," noted Dr. Ebert. "All together, it is 500 pages and 600 requirements."

"There is a substantial amount of infrastructure work to be done in addition to running the processes a carmaker would normally run," explained TRW’s Mr. Miller. "It is not legally required to be compliant to the standard. It is voluntary. Carmakers have been making safety products for years, but the standard is more prescriptive about the evidence to demonstrate that their processes are safe." Mr. Miller highlighted another difficulty carmakers and suppliers face in implementing ISO 26262: the shortage of safety engineers needed to do the extra work and the analysis required to assure compliance to the standard.

Mr. Miller thinks that by the 2016 or 2017 model year almost every carmaker will make compliance with ISO 26262 part of their requirement. "By then noncompliance will be the exception."

Linux Operating Systems Dominate by 2020 Says IHS

By 2020, Linux will take over from QNX as the world’s number-one operating system in infotainment. Linux is the ubiquitous open source operating system used in computers and smartphones. According to Egil Juliussen, director and principal automotive analyst at IHS, who developed the forecast, the automotive tier ones want to control the software platform and that is more easily done on Linux than it is on a QNX or Microsoft OS. By controlling the software, they are more likely to retain the head unit business, which might otherwise go to a contract manufacturer.

Linux is finding multiple paths into infotainment systems. It is the basis for the Genivi platform, which is supported by BMW and PSA, among others. And it is the basis for Automotive Grade Linux (AGL), which is supported by Toyota, Nissan and Jaguar Land Rover, among others. According to Mr. Juliussen, AGL will leverage some of the middleware created by the Genivi alliance.

In the future, Android, which is based on a Linux kernel, will join other guest operating systems on infotainment platforms designed to run multiple operating systems. Android will be used to support downloaded applications not linked to vehicle control systems.

The 2020 unit forecast is based on sales of 100 million light vehicles. By then Mr. Juliussen thinks that each infotainment system platform sold in Europe and North America will make use of two operating systems, on average, whereas low-end vehicles sold in emerging markets such as India will not even feature an infotainment system. LCD-based clusters will be built on operating systems, but these weren’t counted in the totals.

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Elektrobit handled the software integration for the first Ford Sync, a pioneering development in which Ford took system integration in house. Markus Schupfner, vice president of infotainment solutions for Elektrobit, recalled, “A lot of OEMs looked at the success of the Ford Sync One system and said, ‘how do we do that?”

In its e.solutions joint venture with Audi, Elektrobit participated in another pioneering infotainment development that separated the head unit from software parts. According to Mr. Schupfner, Audi even has hardware from two different suppliers, Harman and Nvidia, in one silver box. “The software from e.solutions comes completely integrated on the Nvidia chip set. That was several years ago. By now it has become a worldwide trend. Carmakers have been asking us how we did that, how was Audi able to bring so much innovation to market so quickly,” he said.

Driving the worldwide trend to disaggregate software and hardware, according to Mr. Schupfner, is the inability of traditional infotainment tier ones to continue making the investments required to stay current in all the different software parts. “You now have high-end navigation, connectivity systems, speech recognition and much more. Interfaces to these are becoming standardized and purchased from outside suppliers,” he said.

Elektrobit’s Automotive Software and Services business, totaling roughly 110 million euros in the 2013, has been growing at 20% to 25% per year and is expected to grow even faster over the next few years. The company has been supplying navigation and HMI software, as well as network communications solutions, for a number of years and more recently has moved aggressively into driver assistance solutions.

**Driver Assistance Software**

The growing complexity and importance of software is forcing carmakers into new business relationships. For example, Elektrobit has operated its driver-assistance software factory to support its long-term partner Daimler for three years. Daimler decided to focus its efforts on innovation while leaving the production of software to Elektrobit. Elektrobit delivers 60 driver assistance functions in 200 software modules. The software is distributed to nine different ECUs which are applied to 25 different car models.

Mr. Schupfner expects to expand the software factory services to other customers. “This is not just for Daimler,” he explained. “It is something we invented and we offer to others. We are in discussions with tier ones and other OEMs who are interested in this approach for their infotainment software. A lot of them have difficulty bringing the software toward SOP, making it stable, bringing it to a high quality level and delivering it on time.” Each software factory project would involve between 20 and 40 Elektrobit employees.

The cooperation with Daimler was recently extended to 2020. Elektrobit’s work with Daimler will move beyond driver-assistance software integration to include the development of driver assistance functionality.

In addition, Elektrobit will begin selling some of Daimler’s driver-assistance technology to other carmakers, starting with drowsiness detection IP. The feature will be unbranded. Similar to the way hardware is sold, the license payments will be based on unit volumes. The system monitors steering wheel movement to detect when a driver is getting sleepy. An advanced version of the feature also takes input from a driver monitor camera.

Separately from Daimler, Elektrobit has begun marketing a driver-assistance software development tool it developed in cooperation with Audi Electronics Venture GmbH. The tool goes by the name of EB Assist ADTF, for Automotive Data and Time Triggered Framework. EB Assist ADTF is a flexible and extendable tool for the development of new driver assistance functions in the car.

Another driver-assistance offering from Elektrobit is EB Assist Electronic Horizon Suite, a set of tools, plug-ins and code fragments to develop driver assistance applications that use an electronic horizon, or eHorizon. Generated by the vehicle’s navigation system, eHorizon is predictive data of the route in front of the vehicle. It is used to guide adaptive headlamps into curves, and to inform lane detection and correction systems.

In Mr. Schupfner’s view, driver-assistance architecture may be moving in a similar direction as infotainment, where the system’s head unit runs multiple software components. According to Audi, the car of the future could have a central electronic control unit for piloted driving that collects the sensor information, evaluates the driving situation and calculates the steering, acceleration and braking actuations to be undertaken. The software running in this unit is likely to be even more complex than the software that runs in infotainment head units, requiring software expertise from multiple providers. ◆
Background

In 2012, Kostal marked its 100th year in business. The company was founded in 1912 in Lüdenscheid, Germany, by Leopold Kostal, and is still owned by the Kostal family today. The current chairman, Andreas Kostal, who took the position in 2011, is the fourth generation to lead the company. It is company policy that a family member will be active in management to assure that the family’s interests and the company’s interests are aligned.

Kostal’s initial product line included sockets, plugs and switches for industrial and domestic use. It produced its first automotive part, a turn signal switch, in 1927 and since 1953 has focused almost entirely on the automotive industry. Among the company’s mainstay products, steering column switches have been in production for more than 50 years.

Since 1995, Kostal has been organized into four business units: Automotive Electrical Systems, Connectors, Industrial Electronics and SOMA Test Systems. By far the largest division, Automotive Electrical Systems accounted for 81% of sales in 2013.

As a family-owned operation, Kostal is not constrained by shareholder pressure for short-term profits. Carsten Wolff, vice president for automotive markets and customers, and member of the executive board noted, “Family-owned companies are really devoted to the longterm success of the company. That means sustainable, profitable growth is the most important guidance for all our business actions.” Mr. Wolff is responsible for worldwide sales for the automotive electrical systems business. Kostal provides customers with a global footprint along with the flexibility and commitment of a family-owned and managed medium-sized company.

Strengths

Kostal’s annual automotive sales growth since the start of the global recession in 2008 has outpaced the automotive electronics market. By 2010, Kostal’s Automotive Electrical Systems sales had not only recovered from the global crisis, they surpassed 2007’s pre-recession revenue. Kostal aims to continue its faster-than-market growth, anticipating sales over the next five years will increase at the rate of 5% to 10% per year. Not an acquisitive company, Kostal plans to continue to generate growth from within, through its core competencies and by expanding into new locations.

Kostal’s “Strategy 2020” targets all regions as growth regions. “The growth regions are pretty diversified,” Mr. Wolff observed. “Asia is in the lead, but we are looking into North and South America and Europe as well. Our newest, 100% Kostal-owned company is Kostal India.”

According to the company, its core competencies lie in what it calls integration, and that integration covers five disciplines. Kostal characterizes these as global, technical, vertical, business and human integration.

◆ Global Integration

“We think our global footprint is one of the very strongest competencies we bring to the market,” said Mr. Wolff. “Not only do we have a highly distributed production and development network, we also have a highly standardized structure all over the world in terms of our processes, production equipment, tooling standards and so
on. A project might be launched in two or three regions of the world at the same time with an equal level of quality and functional requirements and still fit into local platforms."

Globally, Kostal employs 1,080 engineers in R&D, product line management and project management. An additional 800-plus support production engineering. Roughly half of Kostal’s engineers are based at the engineering center in Germany, with the other half abroad. Approximately 220 are at Kostal’s R&D center in China and 100 in North America. The remainder are in low labor cost countries including Bulgaria, Ukraine and the Czech Republic, or supporting production facilities in Spain, England and other locations.

**Technical Integration**

Kostal serves not just premium German carmakers, but also high-volume and low-cost carmakers. “Kostal has always fueled our growth by integrating further functionalities into existing products and by integrating different technologies, especially mechanical functions and electronics. Mechatronics is our mission,” Mr. Wolff explained. Kostal has been successful in expanding its switch and switch panel business into lower-end vehicles in developing markets such as China and India.

“The Kostal is not a company that just buys technology and assembles it somehow. We really try to understand the technology we are using and we invest a lot of money in our laboratories. We promise our customers we know what we are doing,” said Jörg Schwerak, vice president of R&D and engineering and member of the executive board. Mr. Schwerak is responsible for R&D, production engineering and product line management for the Kostal Group.

**Vertical Integration**

Kostal maintains in-house competence in multiple stages of metal and plastic manufacturing as well as in pre- and final assemblies. For example, approximately 70% of injection molding is done in house, according to Ludger Lautenberg, president and CEO of the Automotive Electrical Systems business. “These are the three most important areas in our vertical integration: manufacturing single components, electronic printed circuit boards and related assembly, and tooling. We have an in-depth competence in the manufacture of tools,” Dr. Lautenberg said.

**Business Integration**

Kostal competes with the world’s largest tier ones and needs to demonstrate the value it can bring to OEM customers. The company believes it can do so in several ways. If a project is severely cost driven, for
example, Kostal can work with the customer to lower system costs through integration of components into modules, to combine functions into fewer ECUs, or to design systems for more efficient manufacturing and ease of assembly. It also can leverage its in-house expertise to deliver a better end-customer experience than its competitors. “This is another dimension of integration that brings customers to Kostal,” said Mr. Wolff. “If we bring, let’s say, superior surfaces or superior haptics to our customers, we are integrating quality not only in terms of robustness but also in terms of the user’s perception of the product.”

**Human Integration**

Kostal works to create a company culture of community, where all competencies are shared equally throughout the organization. “In addition,” said Mr. Schwerak, “we have functional responsibilities. For example, I am responsible for all R&D centers, so all have the same standards, system set-ups and processes. Frank Blaesing, our head of innovation, signs off on every innovation project in the world, so we know we are not duplicating our efforts.”

**Product Strategy: Variety**

Unlike some medium-sized companies that focus sharply on only a few technologies, Kostal’s strategy is to develop and support multiple technologies, which has the benefit of exposing the company to more future market opportunities as they arise. “Customers work with Kostal rather than a specialist company working in just one field because we can clearly see the relationships among the different technology trends,” Mr. Schwerak asserted. “A second reason is our internal engineering competence set up. We know we need a certain amount of electronics competence in different technology fields, so if one opportunity is not developing as quickly as we anticipated, we can apply those engineering resources to other fields. It makes Kostal a much more stable company than one working purely in, say, electromobility.” Mr. Schwerak gave the example of Kostal’s efforts in HMI, which have expanded from simply making switches and switch panels to include systems that must be integrated with the HMI, such as driver assistance and driver monitoring.

**Most Promising New Products**

**◆ Forward-Looking Driver Assistance Camera**

Kostal’s first generation driver assistance camera launched on Mitsubishi and PSA vehicles in 2012. The company is working with a German premium OEM on the second generation, a world’s-first mono-vision camera capable of supporting automatic emergency braking (AEB), and braking for pedestrians, without the need for a radar sensor to detect range. The new camera complies with Euro NCAP requirements for model year 2014 vehicles to earn five star ratings. The mono-vision camera system is scheduled to go into production at the end of 2014.

A unique feature of the camera is that it attaches directly to the front windshield, eliminating any air gap where dust or moisture could compromise performance. Unlike mirror-mounted solutions, the optical path realized by mounting the camera directly to the windshield (a heated windshield is required) is sufficiently reliable for safety-critical functions. The field of view captured is comparable to the visual perception of the driver.

Driver assistance algorithms, supplied by Mobileye, use multiple, sequential images taken by the camera to compute the exact time to collision with an object, rather than measuring distance to the object. “To do emergency braking, applying full braking force, requires an ASIL-based sensor,” explained Frank Blaesing. “You need redundancy in your sensor. This is not one single algorithm doing all the calculations. There are different algorithms on different information channels inside the sensor. Only if the redundant algorithms come to the same conclusion is the braking action carried out.” Kostal has had an ongoing partnership with Mobileye since 2001.

Future camera applications in development include both driver monitoring and gesture recognition systems based on 3D time-of-flight cameras from PMD Technologies. Time of flight image sensors use light pulses from an LED or laser to measure distance. Kostal is developing its own gesture recognition algorithms for infotainment controls.

**◆ Intelligent Surfaces**

Despite the problems Ford encountered with its MyFord Touch and MyLincoln Touch controls, Kostal believes capacitive switching is one of its more promising new technologies, worthy of considerable investment funding. Ford’s touch capacitive switches were not supplied by Kostal. “With capacitive switching you can make the switches invisible when you are not using them; you create a certain design in the interior of the car,” said Mr. Schwerak. Which functions are most appropriate for capacitive switching? According to Kostal, certainly not all of them and none that would be operated in emergency situations, such as switching on hazard lights, but possibly functions that can be personalized for the driver such as Home in a navigation system or a Call Home button.

Kostal’s capacitive switches are designed to make it difficult to activate them unintentionally. “In our system you can locate the switch with your hand first; every control has some kind of tactile, physical shape,” explained Harry Asher, vice president for product line management and engineering. “The sensor is aware of where you are touching the surface, but you have to apply force to the switch to get the activation. You have more or less a normal switch experience,
but the activation is behind a closed surface.” Kostal’s first application of these switches will be in 2015, for a German luxury carmaker.

With its in-house capabilities in plastics, foil printing, thermoforming and back- and over-molding, Kostal can offer panel surfaces that have no gaps, are less likely to crack, have a high chemical resistance, and a limited “self-healing” property. When the panel surface is heated to 50 degrees C for 24 hours, any small surface scratches disappear. Kostal markets this surface technology for capacitive switch panels under the name Kostal skintec. The company believes the quality and design of its capacitive switch panel surfaces translates to perceived high quality for consumers and brand differentiation for OEMs.

According to Dr. Laufenberg, Kostal’s demonstrations of capacitive switching at the Frankfurt Auto Show in 2013 were well received. “We had great feedback from our customers. We put a lot of upfront engineering work in our design and development and so it works well in any conditions in the vehicle environment. I see more applications based on capacitive switching integrated with intelligent surfaces in panels. It is the dream of every designer,” he said.

**Onboard Charger**
Kostal is the main supplier of onboard battery charge controllers for all of the Volkswagen Group’s plug-in hybrids and battery electric vehicles. In developing the onboard charger, Kostal tapped into the high-voltage expertise in its Industrial division, which supplies power converters to the solar energy industry. “Two years ago we merged that competence with our automotive electronics knowledge and developed this onboard charger that we are now running in series production,” noted Mr. Schwerak.

Kostal’s charger unit supports power line communications (PLC), CHAdeMO, CAN and LIN communications standards. In the future, according to the company, PLC could be employed for billing purposes. The unit could also operate bi-directionally in the future, for example, to provide backup power from the vehicle to a home during power outages.

Although Mr. Schwerak has very low expectations for the electric vehicle market taking off any time soon, “We see a massive increase in plug-in hybrids as a result of CO2 and fleet fuel consumption regulations. Every OEM is bringing a hybrid version to almost every car line in order to meet those new requirements. You need a plug-in hybrid, not just a hybrid that charges the battery with the engine of the car.” The company is working to expand the charger business to other carmakers, but thus far has no contracts.

**Fragrance system for the S Class**
More than seven years ago, Kostal started developing a system that could deliver a selection of fragrances inside the vehicle. That system came to the market in 2013, as an option on the all-new Mercedes S Class. Kostal’s approach in the S Class is to atomize liquid fragrance, which is stored in a bottle in the glove compartment, three millimeters in front of the cabin air vent, to prevent the aroma from building up in the seats or other soft surfaces. Electronics control the frequency of the fragrance injections, which can be adjusted by the driver to increase or decrease the intensity of the smell. The system takes the cabin temperature into account in determining the precise amount of liquid to dispense.

What might seem frivolous or extravagant in Western markets is far more commonplace in Asia, according to Kostal, not only as a means of masking poor air quality but also as a distinguishing luxury feature. But Kostal also sees the fragrance feature as part of a larger future trend toward more intelligent HMI, and cars that will increasingly make adjustments to the in-vehicle environment to support the well-being of the driver. “The car HMI will adjust things like loudness, illumination or smell according to the driving situation or the mood of the driver—whether his mood is good, bad, aggressive, tired, etc. It will make some features available only if you are driving at 100 mph, others only when your speed is very low,” Mr. Schwerak predicted.

He sees a role for intelligent HMI in future autonomous or partially automated driving systems that will need to monitor the driver to assure he can be brought back in control of the vehicle as needed. “An intelligent HMI can help with that,” said Mr. Schwerak, “adjusting the car environment with the appropriate air quality or illumination or other features.”
In December 2013, design automation tools and embedded software supplier Mentor Graphics released its new Mentor Embedded Hypervisor product to the automotive market.

The distinguishing characteristic of Mentor Graphics’ hypervisor is security. “The biggest trend in automotive electronics today is wireless connectivity, and that connection to the outside world heightens security concerns,” said Scott Morrison, general manager of embedded software solutions at Mentor Graphics.

Mentor Graphics’ hypervisor supports TrustZone system security architecture. Licensed by ARM and part of its Cortex-A series cores, TrustZone is hardware-based. According to Texas Instruments, which makes TrustZone part of its Jacinto 6 SoC platform, “TrustZone splits processor cores into two virtual cores, one operating in a normal world and the other working in a secure world. Transitions between the two worlds are carefully controlled.”

With full TrustZone support, Mentor Graphics’ hypervisor can enforce partitioning of memory and devices to ensure that misbehaving applications, either intentional or malicious, cannot disrupt or corrupt other areas of the system.

Mentor Graphics has built its hypervisor to work with ARM’s TrustZone because ARM licensees own by far the largest share of the infotainment market. Wind River and Green Hills Software also produce hypervisors for the automotive market. Green Hills’ Multivisor works on TrustZone cores, but according to Mentor Graphics, Wind River’s product does not.

A hypervisor is software that lets multiple operating systems use a single processor while providing safe separation between applications of varying criticality. You can run applications based on Linux or other open source software on the same single- or multicore processor that’s also running a proprietary application on a different operating system. Android applications can run alongside a legacy application based on OSEK or Autosar. “The hypervisor gives you significant and definitive separation between each system,” said Mr. Morrison.

With just 10,000 to 20,000 lines of code, the Mentor Graphics hypervisor boots quickly, in well under a second, making it well suited to exterior camera monitoring applications.

Dan Loop, automotive business development manager for Freescale, has seen security use cases involving its ARM-based i.MX processors and TrustZone in infotainment systems associated with high bandwidth content protection for multimedia and secure vehicle networking. Mr. Loop expects the market for hypervisors to begin to go mainstream in 2017, climbing to no more than 30% of the IVI processor market by 2019 or 2020.

While infotainment systems will be the primary domain where hypervisors are employed, Mentor Graphics anticipates their applicability in reconfigurable clusters and in driver assistance systems.

Mentor Graphics has been investing in its embedded software portfolio in response to automotive customers who say they want more suppliers who are stable. Mentor Graphics sees itself as considerably more stable than QNX, today the leading supplier of infotainment operating systems. QNX is owned by BlackBerry, which has been operating at a loss.

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**Mentor Graphics’ Hypervisor**

Mentor Graphics’ hypervisor is a small footprint, type-1, meaning it is run directly on the host’s hardware to control it and to manage the guest operating systems.

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**3D Clusters Soon to Ship with Integrity Operating System from Green Hills Software**

Green Hills Software, provider of operating systems, development tools, compilers, debuggers and services, has been selling to auto industry customers for 20 years. Soon the company’s automotive business will accelerate as a number of next-generation 3D cluster applications based on its Integrity operating system find production in 2014 model year vehicles from multiple carmakers.

“A number of tier-one suppliers have selected Integrity as their base operating system for 3D cluster solutions,” said Dan Mender, in charge of global business development for Green Hills Software. “We are seeing a lot of new 3D graphics design wins—for both clusters and head units—involving the combination of our Integrity operating systems and EB Guide as the solution. EB Guide is Elektrobit’s human machine interface development platform.

Green Hills Software is also seeing a lot of interest in its Integrity Multivisor for In-Vehicle Infotainment platform, which lets developers run fully-functional operating systems such as Windows, Linux and Android alongside applications that provide fast-boot, real-time, safety-critical and security-critical capabilities. “Virtualization is a service on top of Integrity,” said Mr. Mender. “You get to run all the critical services as native Integrity applications, but you also get the separation, determinism and resource guarantees. Our Integrity platform is the base of our software solutions not only in infotainment but also in clusters and other ECUs. From there we can provide software expertise to help our automotive customers develop functional safety and security architectures.”

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