Executive Summary

Recent advances in consumer electronics (CE) have mainstreamed the promise of an always-connected lifestyle. Wherever they go, people want—and more importantly expect—to be seamlessly connected to the Internet and the world around them. But the car represents an unacceptable gap in their always-connected experience, and many of them spend 18+ hours in this state each week (average U.S. weekly commute time).

Carmakers are working to close the in-car connectivity gap but have struggled with the complexity of the request. Adding the car-to-cloud connectivity that consumers seek—along with the tablet-like experience they’ve come to enjoy—dramatically increases the design complexity of in-vehicle infotainment (IVI) designs. This results in longer development cycles and higher costs. Carmakers are further constrained by a development process that relies heavily on proprietary designs, yielding a heavy cost and time-to-market burden.

In a world where CE devices undergo a generational change every nine to twelve months, and the typical new car takes at least three years to design and bring to market, a longer development cycle is not a success strategy. The industry needs a new approach—an approach that accelerates the development cycle, brings down the cost of new designs, preserves carmakers’ ability to differentiate and deliver a variety of economical solutions, and provides a mechanism for staying ahead of the latest CE technology.
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## The Auto Industry at a Crossroads

Mounting pressure from consumers for an enhanced and connected in-car technology experience is forcing a reset in the way cars—and specifically in-vehicle infotainment (IVI) systems—are designed, built, and supported after sale. A whole generation of always-connected consumers with brand new driver’s licenses (aka “millennials”) is behind this push.

But it’s not just connectivity that they’re looking for. Mainstream consumers—and especially millennials—expect an experience from their in-car technology similar to what they appreciate about their smartphones and tablets. This fast, engaging, and always-evolving experience is enjoyable—and they want it with every device they come into contact with. Their cars are no exception. And because IVI technology has been offered in higher-end vehicles for some time now, mainstream consumers are starting to ask: “where’s ours?”

## Cycles Out of Synch

Building cars is a complex, time-consuming, costly process. It takes billions of investment dollars and at least three years of engineering and development to get from prototype to production. Real ROI is only realized after many years of selling the same designs over and over again. Carmakers tweak their designs every automotive model year, but real generational evolution happens less often—three-to-ten years in most cases. This matches the ten-year average life expectancy for cars coming off the assembly line today.

Contrast the lengthy development and life cycle of the car with the CE industry and you get an understanding of the dilemma facing carmakers today. They simply can’t go fast enough on new designs to keep up with the changes in consumer electronics technology.
**Searching for a Faster Path**

Part of what makes the process so lengthy is the historical development model that keeps carmakers hitched to proprietary technology. This is by design, as carmakers have long required automotive “Tier 1s” to use custom designs locked down across several automotive model cycles to ensure differentiation between carmakers. Under this model, Tier 1’s are sometimes forbidden from applying their development effort from one carmaker’s solution to that of another carmaker.

The time and cost burden of this proprietary, legacy development model is staggering. Switching platforms, adding features, evolving technology—each of those steps requires from-the-ground-up engineering that costs money and takes time, thereby lengthening life cycles. What’s more, the redundant development effort that occurs with this model dramatically slows the time it takes to deliver new solutions. Even in cases where Tier 1’s are able to build from their own baseline platform, new requirements arrive that are built from scratch. The amount of money, time, and energy wasted on redundant development effort is huge. But the unintended side effect of this policy is an enormous software and hardware burden that adds to their costs—costs that must be passed along to carmakers and ultimately car buyers.

The custom and proprietary model also makes it more difficult for carmakers to scale their solutions to an affordable price point for mainstream consumers and still deliver the kinds of features they want today. IVI systems are some of the most complex computing devices on the planet, and they are becoming more so, operating as a multi-user system for each driver and passenger, often with multiple screens and sound paths.

This complexity requires agility in design and ultra-fast time to market. But since the IVI innovation cycle is also tied directly to the overall drivetrain, car body, brakes, and suspension development, mid-cycle innovation is impossible to integrate, much less during the average ownership experience. This chasm not only costs money but represents a steep cliff for the car-buyer seeking a dynamic, fully connected experience at an affordable price.

“The automotive industry is going to have to collaborate ... on the code and requirements to produce a common base, upon which they differentiate and compete with each other.”

—Jim Zemlin, CEO of the Linux Foundation, article in WiredOpinion, October 12, 2012
DeVelopIng In-car technology for the fast lane

The Road to Success

What carmakers need is a way to streamline and accelerate the development of IVI solutions and provide an upgrade path for installed IVI systems once cars leave their lots. They need a development model that is more cost-efficient than the proprietary system in place now. And they need to be able to deliver in large volume. Their road to success includes: standards-based components, an accelerated model for innovation, and the elevation of IVI to the “intelligent systems” category of devices.

Open Choice: Bold Possibilities

Intel is one of the leading contributors to the Linux* kernel, and—along with other leaders in the automotive industry—champions the use of an open source operating system for the automotive industry. Through the GENIVI Alliance, a consortium of Tier 1s, carmakers, silicon providers, ISVs, and others, Intel and the industry are driving broad adoption of an IVI open source development platform based on the Linux operating system. Intel currently has hundreds of engineers working to ensure that this development environment succeeds in making possible faster and more cost-effective IVI designs.

The success of Intel’s and GENIVI’s efforts are evident: Many Tier 1s and carmakers are beginning to adopt the recommendations of the alliance as they build next-generation IVI systems. There are three reasons the industry is embracing this approach:

Innovation: Through the energy and ideas of a worldwide talent pool, the pace of innovation quickens and technology breakthroughs emerge.

Flexibility: Access to source code makes it possible to craft customized solutions from proven open-source components that effectively meet very precise and detailed customer requirements.

Cost Optimization: With a whole industry working together on an automotive open source platform, the cost of development drops dramatically.

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Accelerating Innovation
Many auto industry leaders consider open source and standards-based technologies to be a winning strategy. They are starting to realize shorter product development and life cycles as they adopt this approach, and they are becoming more comfortable with their ability to innovate and differentiate on these open platforms.

With development of a base level platform out of the way, carmakers and Tier 1s can turn their attention to the unique user interface and package of features they want to offer to the customer. This is mostly a software effort—a significant one at that—but an effort that starts with the support of existing ecosystem solutions, including mainstream applications, and connectivity standards. The time saved on development by starting at the midway point is potentially huge, and will dramatically accelerate the pace of innovation in IVI systems and get them closer to the end goal: matching the cadence of the CE industry.

An Intelligence Upgrade
Allowing the car to act as the control center of a mobile computing ecosystem gets to the heart of how future IVI systems should behave. This requires an intelligence upgrade that enables things like car-to-cloud connectivity, in-vehicle device manager, entertainment hub, informational conduit, location-aware support system, and more.

Unlike the basic IVI platforms that power the typical in-car entertainment or GPS navigation, intelligent IVI systems can be modified after installation by over-the-wire data transfers. They can sense key variables in their environment. They can remember the way passengers wanted it the last time, and go right back to that point the next time. This kind of intelligence is necessary to support the tablet- and smartphone-type experiences that consumers are demanding.

“Members of the automotive ecosystem are collaborating on a next-generation infotainment platform and operating system for the car through the GENIVI alliance—and Intel is helping to nurture open-source technologies and companies in working with ecosystems like GENIVI.”

—Tim Yeaton, President and CEO, Black Duck Software
Why Intel?

Using this new three-part approach (standardized, intelligent, accelerated) to IVI development, carmakers will be able to meet consumer demand for an intelligent connected in-car experience. Intel is helping ensure the industry succeeds on this path, bringing the ideal combination of experience, technology capability, partnerships, and groundbreaking user research that carmakers require to realize the full potential of IVI.

**Single CPU architecture.** All Intel® processors use the same microarchitecture, enabling common software development that endures across generations, and software and hardware solution scalability and consistency across systems—from low to high-end designs.

**Silicon plus.** In addition to producing industry-leading silicon, Intel also designs and manufacturers industry-leading components needed for IVI systems, including SSDs and communications modules.

**Strategic partnerships.** Intel has invested heavily in strategic auto industry partnerships that support the development of a better IVI solution model. These partnerships include: academic institutions, an extensive ecosystem of third-party software and hardware vendors, leading automakers, Tier 1s, and the GENIVI Alliance.

**World class manufacturing capability/capacity.** With billions of dollars invested in state-of-the-art manufacturing capability and capacity around the globe, Intel can deliver the quality and volume of silicon needed to power a whole generation of IVI systems across the entire industry.

**Automotive R&D, innovation.** Intel invests heavily in automotive-relevant R&D, including connectivity, security, and virtualization. Intel also opened an Automotive Innovation and Product Development Center in Karlsruhe, Germany specifically to address the needs of the automotive industry. And Intel Labs conduct user experience research around the world—insight that is valuable for IVI system development.
**Software investment.** Intel provides significant support for automotive software development.

- As a software company, Intel would be the sixth largest in the world.
- Intel operates the third-largest software development program in the world, after Microsoft Developer Network* and IBM.
- More than 11,000 companies are in the Intel® Software Partner Program.
- There are 400,000 Intel® Software Network subscribers.
- Eighty-five percent of ISVs use Intel® tools for development.
- More than 10,000 employees on Intel's payroll are dedicated to software development.
- Intel has invested millions of dollars to lead the development of open source software. (See related sidebar: Open Choice: Bold Possibilities)

**Intel® Capital Connected Car fund.** A first of its kind, the USD 100 million Intel® Capital Connected Car Fund is being invested globally in hardware, software, and services companies developing technologies to promote new, compelling in-vehicle applications and enable the seamless connection between vehicles and any connected device, including mobile devices and sensors.

**Broad footprint benefits automotive.** Adjacent and relevant successes include: telecommunications, enterprise IT, the cloud, consumer electronics devices, and mobile computing. Technology from each of these industries is used in IVI systems, and Intel can help the automotive industry best utilize key features.

**Moving to the Fast Lane**

As more and more carmakers adopt standards based hardware systems and open source technology for their IVI systems, the industry will begin to accelerate delivery of the always-connected lifestyle consumers seek. It’s a success strategy for bringing IVI to the mainstream and helping carmakers move their development cycles into the fast lane.
The Industry Chooses Intel

Intel’s investment in the automotive industry has fueled a number of positive breakthroughs for several carmakers and Tier 1s. Following is a short list of some of the many announced Intel® architecture-based solutions:

BMW. BMW’s cross-platform, high-end infotainment system will be based on Harman Becker’s next-generation infotainment system with the Intel® Atom™ processor.

> Harman’s press release announcing the award from BMW

Daimler. Harman Becker was selected by Daimler to provide the next-generation COMAND infotainment system for the automaker’s new Mercedes-Benz S- and C-Class models.

> Harman’s press release announcing the award from Daimler
http://www.harman.com/EN-US/Newscenter/Pages/HarmanInternationaltoProvideNext-GenerationInfotainmentSystemforMercedes-Benz.aspx#.UKbByYVQjFU

Geely. Geely’s new IVI system for EC series car models—the Gnetlink—features the Intel Atom processor and was developed by Bluestar.

Guangzhou Automobile Industry Group Co., LTD (GAIG). China TSP and GAIG are jointly developing telematics products and are offering an IVI system based on the Intel Atom processor and a Linux operating system.

HAWTAI. HAWTAI’s new B11 luxury sedan incorporates the Intel Atom processor and open-source software platform in its in-vehicle-infotainment systems, developed by Bluestar.

Hyundai Motor Company, Kia Motors Corp. Intel, Hyundai Motor Company, Kia Motors Corp. and C&S Technology, are collaborating to develop IVI platforms that will bring new services and content, such as location-based applications, social networking capabilities, and entertainment.

Nissan. A Nissan twin-display concept will be featured in their next-generation IVI system in select Nissan production models starting in 2013, enabling the driver to see vital traffic information and navigation while simultaneously delivering entertainment, such as movies, to passengers.

> Intel press release
http://newsroom.intel.com/community/intel_newsroom/blog/2012/04/05/intel-technology-selected-for-nissan-motor-companys-next-gen-in-vehicle-infotainment-systems

Toyota. Toyota and Intel are working together to define next generation IVI systems that will enable new user interaction methods including touch, gesture, and voice technologies as well as information management for the driver.

For More Information
To learn more about Intel’s work in automotive, please visit intel.com/automotive
To opt-in to receive automotive technology updates from Intel go to https://ilms.intel.com/microsite/embedded/pulse/0.ashx
Also visit: www.genivi.org