Automotive Safety Innovations: When Will Zero Fatalities Become a Reality?

Technology Innovation at Work white paper series

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Introduction

What was once the quintessential dream of industrialized nations—the freedom of having your own car—is quickly becoming a dream fulfilled for the rest of the world. In 2010, about 77 million vehicles were produced worldwide, 18 million of those for the Chinese market. In 2012, global vehicle demand is expected to reach more than 80 million, topping 100 million by the end of this decade, according to IHS Global Insight. Asian markets will account for 46 percent of 2012 demand, and sales are trending up in countries such as Brazil, India and China.

Mobility certainly enhances quality of life, but can come at a steep cost. The World Health Organization counts 1.2 million people killed on world roads every year. WHO forecasts annual road fatalities to rise to 1.9 million by 2020. Road deaths are currently the number one cause of death for young people worldwide. By 2015, vehicle deaths will be the leading health burden for children over the age of five in developing countries. The economic cost to developing countries is estimated at close to \$100 billion per year. Making vehicles safer is not only a moral imperative but an economic one as well.

Freescale is committed to the goal of better safety in the automotive segment. As the number one supplier of sensors for airbags, the number one supplier of semiconductors to North American vehicle manufacturers and a leader in many other global automotive semiconductor segments, Freescale is well positioned to help automotive manufacturers make a difference. Our broad and deep portfolio of semiconductor solutions, plus a worldwide network of design centers and development labs, put us in position to meet the diverse needs of automotive manufacturers and automotive regulations around the world. Our diverse portfolio of SafeAssure functional safety solutions is designed to help system manufacturers more easily achieve compliance with the requirements of ISO 26262 standard. The Freescale systems-based approach combines our products into easy-to-use solutions that help get safer vehicles on the road more quickly and with less cost.

Electronic Systems Save Lives

Electronic systems are the source of improved safety. A "safe system" approach is needed to make vehicles safer. The introduction of airbags, followed by active safety systems such as electronic stability control and radar, have already reduced fatalities in developed countries significantly. Airbag regulations in Europe, for example, drove road fatalities down from about 75,000 a year to less than 60,000 in the 1990s. Electronic stability controls and other active safety measures have cut the number to below 40,000. The European Union's goal is that predictive safety and advanced driver assistance systems (ADAS) will ultimately reduce road fatalities per year to less than 13,000 by 2020.

Contrast this with the safety market in developing countries. A critical safety measure that consumers in developed nations take for granted—the airbag—is still uncommon in nations where car culture is growing the fastest. There is no doubt that airbags improve survivability in accidents. Combined with seatbelts, airbags offer one of the most efficient life-saving systems when crashes occur. Passive safety systems such as front and side airbags are becoming mandated by governments in developing countries. In Brazil, for example, only 20 percent of vehicles currently have airbags, but government regulation beginning in 2014 will require all vehicles to have driver and passenger airbags. Fewer than 12 percent of vehicles in India have airbags, but front airbags will be mandated beginning in 2013.

For optimal safety outcomes, consumer adoption needs to outpace regulation. New car assessment programs (NCAPs), familiar for issuing "five star" crash ratings in developed countries, are taking hold in countries such as China and Brazil. Consumers are beginning to understand that these star ratings are the result of rigorous testing, and this helps them choose safer vehicles. Cost, however, is a prime consideration in a major purchase such as a vehicle, so lowering the cost of safety solutions must be a primary goal for all companies in the automotive supply chain.

Airbag Innovation

Freescale and the Bosch Group's Automotive Electronics Division are using their system expertise and global leadership positions to introduce a cost-effective and scalable automotive airbag evaluation platform for the growing automotive safety segment in emerging markets. An airbag is a complex system involving multiple components. Getting started with the design of airbag electronic control units takes time and resources. An engineer must find the right MCU, the right mixed signal ASSP and the right acceleration sensors, and then make sure all of the devices work properly together. The engineer must define the right safety concept and write all of the software routines to get all the parts working together.

The airbag evaluation platform contains key elements to help companies get started faster. It is based on chipsets

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from Freescale's Qorivva 32-bit MCU family and Bosch's Automotive Electronics Division Airbag ASSP family. It works with sensors from both companies, including Freescale Xtrinsic intelligent sensing solutions. It demonstrates how the Freescale Qorivva MPC560xP family of scalable 32-bit MCUs used for safety applications works with Bosch's Automotive Electronics Division CG147 Airbag ASSP family, which is a single, integrated airbag system IC that combines power supply, firing loops, sensor interfaces and a safety controller. The evaluation platform comes with preloaded demonstration software.

Motorcycle drivers are also at risk from crashes. Powered two wheelers account for only one percent of European traffic, but represent 16 percent of the road fatalities. The risk of being killed in a motorcycle accident is 20 times higher than in a regular passenger car. Bering, a well-known manufacturer of motorcycle clothes, has launched an innovative motorcycle airbag jacket intended to reduce bikers' injuries and fatalities, the Bering Wireless Airbag Safety System. The solution is designed around Freescale Xtrinsic MEMS accelerometers and Freescale MCUs-proven automotive technology used in millions of passenger car airbag systems around the world. It uses automotive crash sensors to detect real impact with other road users, dedicated sensors to detect if the motorcycle is sliding (cornering on a slippery road, for example) and the command to inflate the airbag jacket is transmitted wirelessly in less than 0.05 seconds. Full protection takes less than 0.08 seconds.

Advanced Driver Assistance Systems

As automotive safety technology improves and becomes more widely available, the next logical step is to move from keeping bodies safe in a crash to actively preventing accidents. Advanced driver assistance systems (ADAS) are one of the fastest growing safety application areas. Developing an ADAS system requires state-of-the-art, costeffective RF technology that can be embedded in the vehicle. Extraordinary computation power is needed to make the system efficient and reliable for the driver.

ADAS features can be divided into two categories: comfort and active. Comfort ADAS provides warnings or information for the driver. They have no specific functional safety requirements (as described by the ISO 26262 standard) and could potentially be combined with the display of a dashboard infotainment system. These systems include blind spot detection using short-range radar, lane detection, traffic sign recognition, night vision and object detection using a front-view camera, rear-view camera parking assistance with optional object detection, multi-camera parking assistance with a panoramic view and ultrasonic parking assistance. Active ADAS are typically stand-alone, autonomous systems that actively influence the car. They have high functional safety requirements on a system level, but not on a sensor level. Applications include adaptive cruise control using longrange radar, adaptive headlamp control using a front view camera and lane keeping with active steering using a front view camera. Collision avoidance systems provide full-stop emergency braking using a fusion of long-range radar and a front view camera or stereo camera.

ADAS technology is expected to be driven by new regulations and NCAP ratings through this decade and the next. Advanced emergency braking systems (AEBS) and lanedeparture warning (LDW) will be mandated for trucks greater than 3.5 tons in Japan by 2013 and in Europe by 2014. Freescale estimates that forward collision warning (FCW) and LDW will be part of NCAP testing in the United States in 2012, while FCW, AEBS, LDW and blind spot detection will be part of European NCAP star ratings by 2014. Back-up assistance is expected to be mandatory for SUVs and vans in the U.S. by 2015, and AEBS should be mandatory for new cars in Japan, the U.S. and Europe by 2020.

Radar for Collision Warning

In the Freescale collision warning system, a 77 GHz silicon germanium (SiGe) chipset transmitter emits signals reflected from objects ahead, at the side and to the rear of the vehicle; the signals are captured by multiple receivers integrated throughout the vehicle. The radar system can detect and track objects in the frequency domain, warn the driver of an imminent collision and initiate electronic stability control intervention.

This radar solution provides long- and mid-range functionality, allowing one radar system to be used for multiple safety systems including adaptive cruise control, headway alert, collision warning, and mitigation and brake support. Solidstate technology provides the highest level of integration and the most advanced SiGe technology with multi-channel

Products for Automotive Safety

Freescale has created highly innovative integrated systems that have helped put advanced chassis and safety systems on the road. Our ongoing efforts to extend the capabilities of these systems include:

- Advanced chipset solutions for increasing performance and lowering costs in high-volume airbag systems
 - The Freescale Qorivva MPC560xP scalable MCU family for safety applications is part of the automotive airbag evaluation platform developed by Freescale and Bosch's Automotive Electronics Division. It features an e200z0 Power Architecture[®] core running at 64 MHz and scalable flash memory up to 512 KB in an LQFP package.
 - The Freescale MC33789 Airbag System Basis Chip is a mixed signal IC for airbag safety applications. The 33789 provides a cost effective and flexible system IC solution across the range of airbag partitions used in cars and other vehicles.
- Comprehensive systems on chip for anti-lock braking systems, including automotive MCUs, FlexRay controllers, high- side and low-side switches and motor drivers.
- Front-end solution for high-resolution radar with the Freescale 77 GHz SiGe chipset. A typical Freescale RF front-end solution consists of a transmitter chip with an integrated PLL, power amplifier and local oscillator output and an on-chip ramp generator, along with one or several multi-channel receivers that provide the low-noise down conversion of the radar signals into the intermediate frequencies domain.
- Integrating Xtrinsic intelligent sensing technologies into costefficient System in Package (SiP) solutions that deliver boardlevel functionality for automotive systems.
- The Freescale tire pressure monitoring system provides realtime tire pressure monitoring. TPMS employs a pressure sensor, an 8-bit MCU, an RF transmitter and a 2-axis accelerometer sensor with X and Z axis installed in a module on the wheel rims to provide independent, real-time air pressure measurements for each tire that can be transmitted to the vehicle instrument cluster to instantly inform the driver.
- The Freescale i.MX 6 series of applications processors is a scalable multicore platform that includes single-, dualand quad-core families based on the ARM[®] Cortex[™]-A9 architecture for next-generation consumer, industrial and automotive applications. High-performance multimedia options include LVDS, HDMI v1.4, MIPI DSI display port and MIPI CSI-2 camera port, as well as the ability to support up to four screens simultaneously, making i.MX 6 an ideal processor for automotive ADAS camera applications such as 3D, 360-degree views.

transmitter and receiver chips. The lack of moving parts makes the system extremely reliable.

Ethernet AVB Camera System

Ethernet is emerging as a viable alternative to conventional video communication in vehicles. Ethernet Audio Video Bridging (AVB) is part of a technical standard that will allow low-latency streaming video over IEEE® 802 networks. Ethernet AVB uses low-cost unshielded twisted pair cable, supports high bandwidth up to 250 Mb/s, and is widely adopted and understood. The Freescale panorama camera project uses the first Qorivva MCU on the market with embedded Ethernet AVB. This highly integrated solution significantly reduces wiring cost, replacing expensive screened low-voltage differential signaling (LDVS) cabling with 2-wire CAN cabling running time-stamped Ethernet protocol. The application uses up to five cameras to provide images from a vehicle's environment. Software removes fish-eye lens warping, stitches camera images together for a panoramic image, and renders images as textures on a 3D environment model to generate a richer picture. The goal of this pilot

project is to reduce costs and provide better images for camera-based safety systems.



SafeAssure Functional Safety Program

Electronic safety systems, with their direct impact on human well being, are experiencing increasingly stringent requirements. Designing safety systems while meeting stateof-the-art functional safety requirements can be a challenging job for system designers—especially when they are also managing increased application complexity combined with time to market urgency. Functional safety is achieved when there is the absence of unreasonable risk due to hazards caused by the malfunctioning of electrical/electronic systems. The challenge for system engineers is to architect their system in a way that prevents dangerous failures or at least sufficiently controls them when they occur.

The Freescale SafeAssure functional safety program is designed to help system manufacturers more easily achieve system compliance with functional safety standards: International Standards Organization (ISO) 26262 and International Electrotechnical Commission (IEC) 61508. The program highlights Freescale solutions, hardware and software, that are optimally designed to support functional safety implementations and come with a rich set of enablement collateral. SafeAssure solutions reduce the time required to develop safety systems that comply with ISO 26262 and IEC 61508 standards.

Whether your need is to attain ASIL-A to D or SIL- 1 to 4 system compliance, the SafeAssure program enables easier identification of products targeted for use in the effective implementation of functional safety technologies. At the heart of Freescale safety solutions is a focus on quality. From design to manufacturing, Freescale employs the ISO TS 16949 Certified Quality Management System as well as a zero defects methodology to help ensure our products meet the rigorous demands of safety applications and standards in the automotive and industrial markets. Our automotive components are qualified to AEC-Q100 standards.

The Future of Safety

The future of automotive safety lies in the same area as the rest of computing: connectivity. Cars will become their own small networks, with systems exchanging information about everything from road conditions to tire pressure to whether the driver is showing signs of fatigue. In turn, these in-car networks will become elements in a larger network of vehicles. Similar to how GPS knows a car's position and can help drivers identify areas of road construction and traffic jams, cars will be able to communicate with each other in broad networks that improve traffic flow and warn vehicles about impending obstacles or crashes. Vehicles could, for example, not only connect to a weather service, but also be able to know if severe weather is creating hazardous conditions such as icy roads in a specific area. Security will become increasingly important in a world where a hacker could not only steal personal data from a car's database, but also access road control systems to cause impenetrable traffic jams. Freescale Qorivva MCUs bring advanced security to automotive applications. They are the first MCUs for the automotive market that incorporate a cryptographic services engine that meets the Secure Hardware Encryption specification. This specification was developed under the umbrella of the Hersteller Initiative Software consortium of European carmakers.

Your Partner in Automotive Safety

Freescale and other companies in the automotive supply chain share common goals: zero emissions, zero defects and zero fatalities. Automotive electronics are imperative to balancing increasing individual transportation and reducing fuel cost, emissions and casualties. Consumer awareness, legislation and competitive differentiation are all joining forces to drive the world to a safer place.

Freescale Product Longevity Statement

Freescale is committed to long-term investment in the technology needed to help ensure that automotive chassis and safety systems will dramatically improve from one generation to the next. We provide a product longevity program for the market segments we serve. For the automotive and medical segments, Freescale will make a broad range of devices available for a minimum period of 15 years. For all other market segments in which Freescale participates, Freescale will make a broad range of devices available for a minimum period of 10 years. For terms and conditions and to obtain a list of available products, please visit **freescale.com/productlongevity.**

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