Reducing Vehicle Accident Rate and Severity through Technology

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Abstract

Bosch has been at the forefront of vehicle safety technology ever since the introduction of the headlight, and until now the implementation of safety improvements within vehicles has largely concentrated on stand alone safety systems for the vehicle driver and passengers.
Now, with the introduction of sensor fusion, networking and inter-connectivity, Bosch is increasingly looking at how they can influence the complete vehicle / traffic / road infrastructure safety scenario through technology implementation and bring about the long term target of zero accidents.
Locally in Australia we have introduced a project called "Reducing Vehicle Accident Rate and Severity". The objective is to examine how we can reduce the accident rate and mitigate the severity through implementation and networking of current and future technologies, how we can most effectively interface with other organisations that are trying to achieve the same outcome, and finally how we can best educate all road users of the use cases and benefits of the new technology.
This presentation aims to outline the technologies that we are introducing, how they can be networked and the other activities aimed at achieving the overall target of zero accidents.

Keywords

Zero accidents, Vehicle Safety, C-ITS,

Introduction

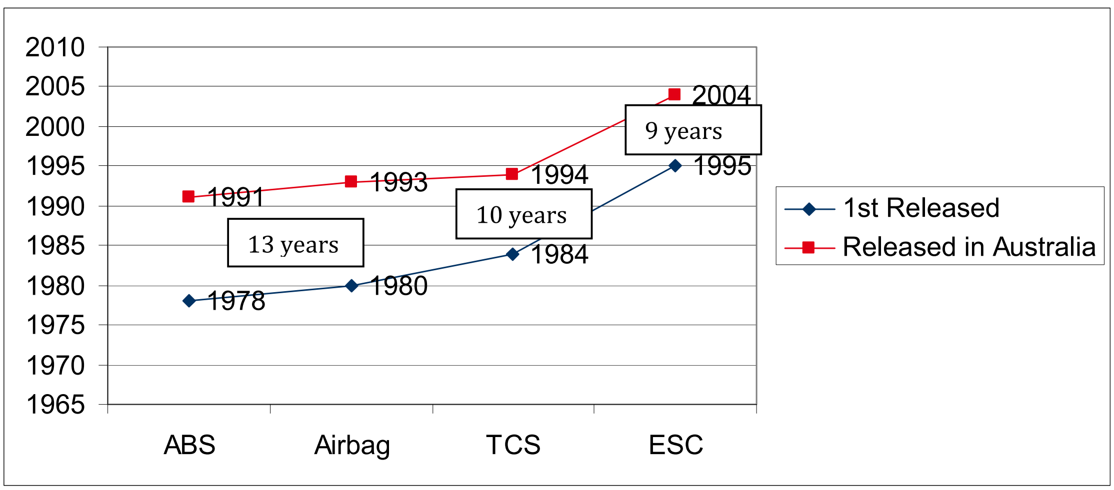
No one denies that the introduction of automobiles has revolutionised the world. When Mrs Benz drove her husband’s experimental car in 1888 from Mannheim to Pforzheim in Southern Germany, a distance of just over 100km, and returned the following day, she sparked a love affair between people and powered travel that would sweep the world. Little did she know that she would also start an epidemic that would claim the lives of more than 40 million people in the following 120 years.
It was only 8 years after that first road trip when the first road fatality occurred with the death of a pedestrian in London. Although the car involved had a top speed of only 6 km/h the unfortunate pedestrian, a lady by the name of Bridget Driscoll, was taken completely unawares as she stepped off the curb directly in front of the slow moving vehicle and unfortunately died of her injuries at the scene.
Uproar regarding how dangerous these new powered vehicles were followed, but the lure of modern transport prevailed and the modern motorised transport industry boomed. Regrettably the number of vehicle related injuries and deaths also grew and despite the hard work of some individuals it wasn’t until the 1960’s that safety gained a level of balance in line with the other requirements of motor vehicle design.
Initially the focus on safety was led primarily by a few influential engineers inside some of the car companies. Those same car companies entered into collaboration with selected automotive suppliers to achieve improved vehicle occupant outcomes. One example of this

was Mercedes Benz collaborating with Robert Bosch, a collaboration that has continued through until today and represents similar co-operations that have occurred with many other car companies and suppliers around the world.
It is this type of collaboration that is now being extended to organisations outside of the traditional automotive design and manufacturing that is bringing about the next innovations that will support further reductions in road trauma.

Discussion

The worldwide introduction of ABS in 1978 to passenger vehicles was the result of joint research and development over the previous decade between Mercedes Benz and Robert Bosch. This was followed in 1980 by the airbag, in 1984 by Traction Control and then in 1995 by Electronic Stability Control. The speed of this technology adoption in Australia initially was relatively slow. ABS was first released in an Australian made vehicle in 1991, airbags in 1993, traction control in 1995 and ESC in 2004 (Table 1).

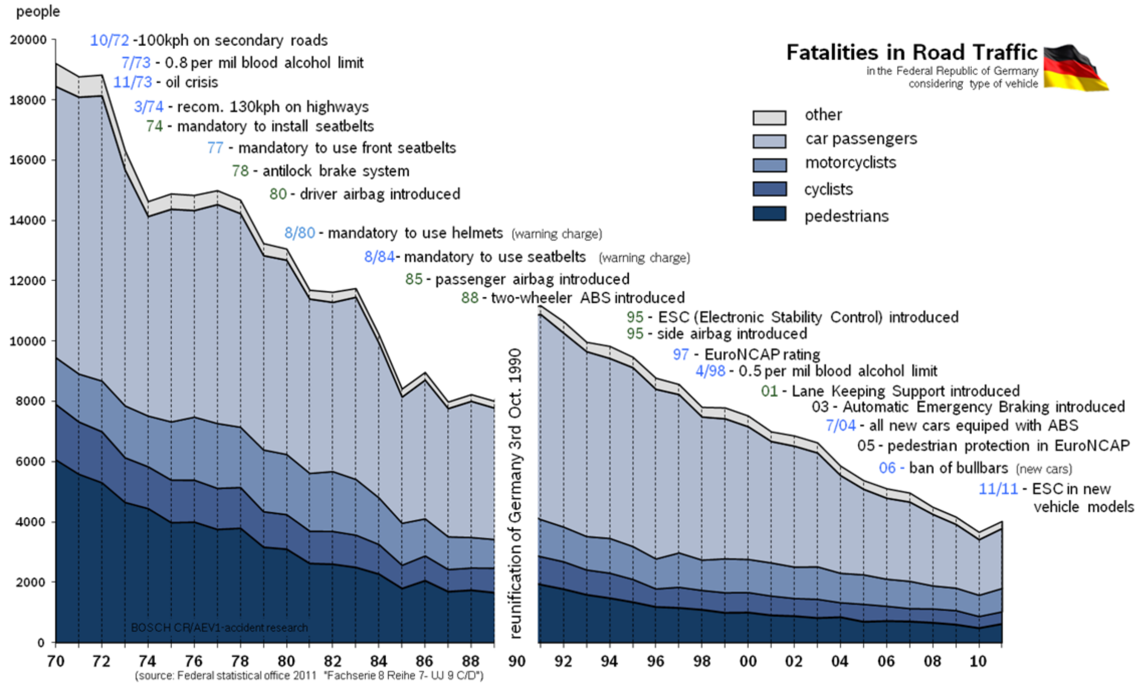
Table 1
Delay in Technology Transfer to Australia



Thankfully in the last 10 years the rate at which new technology is being adopted from elsewhere in the world has increased dramatically. Already we are seeing basic variants of Predictive Emergency Braking, which has been in production only since 2010, being rolled out on a number of vehicle models globally, and here within Australia GM Holden's new VF Commodore has a range of Advanced Driver Assistance Systems (ADAS) that were only first released elsewhere in the world in the last 5 years.

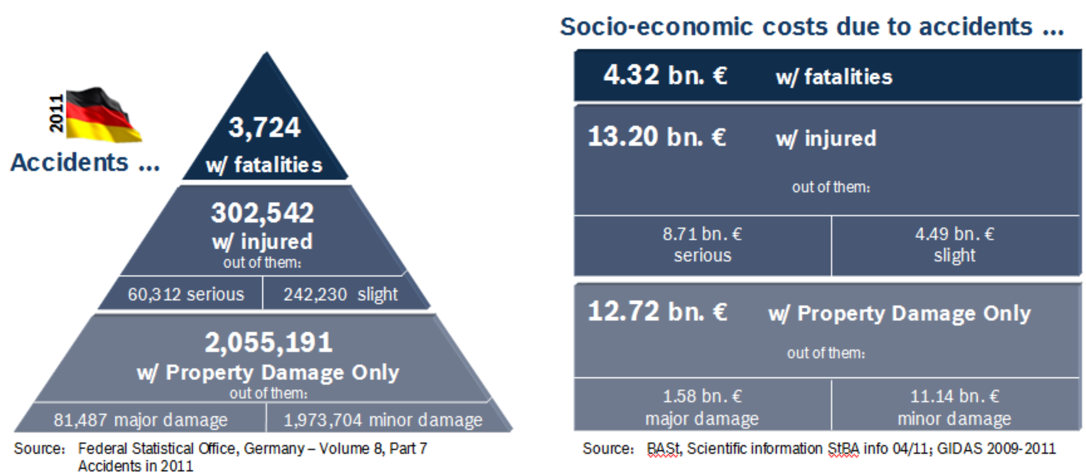
The rollout of technology had a profound effect on the reduction of fatalities and injuries, and quite clearly on the socio-economic costs. Studies worldwide point to periods when new vehicle technology was introduced or mandated and a subsequent improvement on accident outcomes realised.
Of course there are many factors involved and this is not to deny any of them, but in Germany, for example, the introduction of a range of safety measures can be clearly aligned to subsequent reductions in fatalities. (Table 2.) These measures include the introduction of alcohol limits, mandated use of safety belts along with new technology such as Airbags and ESC.

Table 2
Fatalities in Road Traffic in Germany



In a study sponsored by the federal government in Germany an examination was made of the socio-economic costs of road traffic accidents reported to police in 2011. In Germany, by law, all accidents however minor are to be reported to police. Consequently it is possible to create a fairly accurate picture of accidents and the related socio-economic costs to society. (Table 4)

Table 4
Socio-economic costs of German police reported road traffic accidents (2011)



There were approximately 2.36 million police-reported crashes in 2011 which has led to a calculation of approximately 30.23 billion Euro ($39.3B AUD) socio-economic costs due to road traffic accidents. So even putting aside the social impact, the economic benefits of reducing road trauma can be enormous.

The safety technologies that has so far been introduced and demonstrated to be effective worldwide in reducing road trauma are the building blocks of the technology of the future.
Prof. Dr. Herbert Baum from the University of Cologne's Institute for Transport Economics wrote in January 2007 "ESP represents a building block of intelligence on the roads. The ESP benefits – provided that the entire car fleet is equipped – accrue to about 10 – 16 bill. € per year. With that, ESP is a key element of a European Intelligent Transport System."

The UN Decade of Action has helped to focus governments around the world on both the social and economic benefits of increasing road safety. One very positive and relatively easy measure for governments to take was to legislate for standard fitment of ESC, with Australia notably playing a leading role in this trend. This had a drastic impact upon the penetration rate of ESC and we can expect that over time, based on current indications to date, a further modest reduction in fatalities. Significantly, as suggested by Prof. Dr. Baum, ESC is a key element for the introduction of further technologies that will help us take vehicle safety to a new level and now that this is occurring we have a unique opportunity to capitalise on this foundation stone and bring forward a plethora of ideas that will further reduce road trauma.

Advanced Driver Assistance Systems, or ADAS, without ESC are generally warning functions. Examples of this include Blind Spot Detection, Lane Departure Waning and Cross Traffic Alert. While on their own they are valuable warning systems, research has shown that their effectiveness can be reduced over time by a variety factors including false detections, distraction and self modified driver behaviour. To be totally effective the warning systems are reliant upon the driver deciding to respond quickly and appropriately to the given warning. Research conducted by Bosch has shown that the warnings are sometimes ignored, even by experienced drivers.

To achieve the absolute effectiveness of ADAS a link needs to be made to autonomous intervention. In the case of braking this is done via the ESC. If a steering input is required then this can be achieved via Electric Power Steering. Once these safety systems are networked together within a car then it is possible to achieve the maximum benefit from the ADAS features in the vehicle. Consequently we are now seeing Autonomous Emergency Braking filtering into the market.

The public, as they become more aware of these systems and their benefits, are also showing an increased willingness to pay for this increased level of safety. Research published by the Institut für angewandte Marketing- und Kommunikationsforschung GmbH, or IMK, in Germany, entitled "eSafetyChallenge 2011. Car users' acceptance of eSafety technologies" has shown that in a study of 5000 people across 10 European countries that while the awareness of ESC and AEB grew by 11% and 12% respectively from 2009 to 2011, that the willingness of the same people to pay for that same technology grew by 26% and 12% during the same period (Tables 3&4).

Table 3
Awareness of eSafety Systems 2009-2011

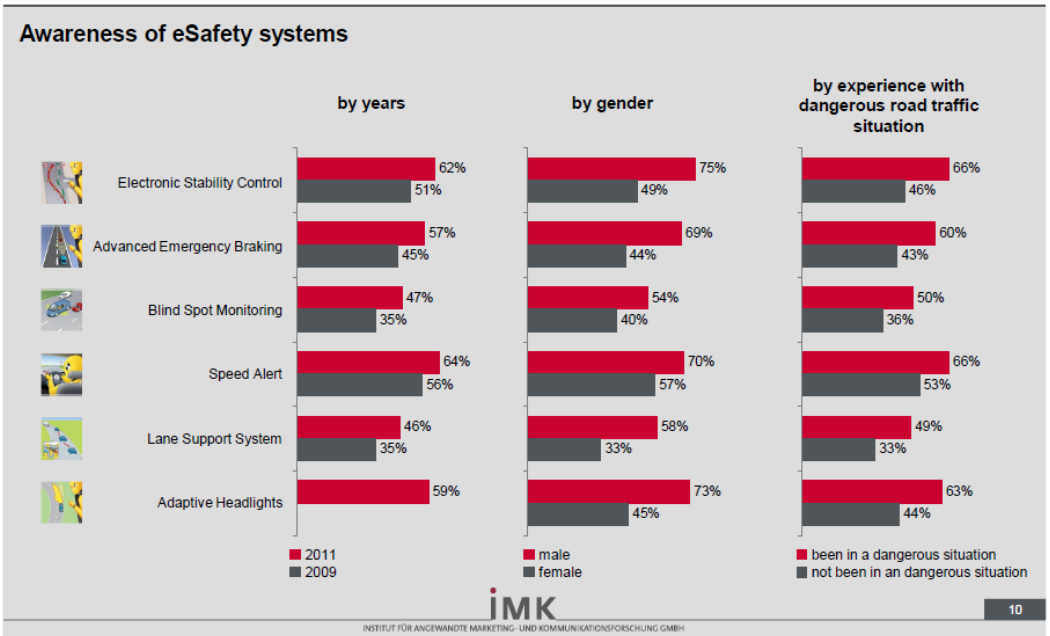
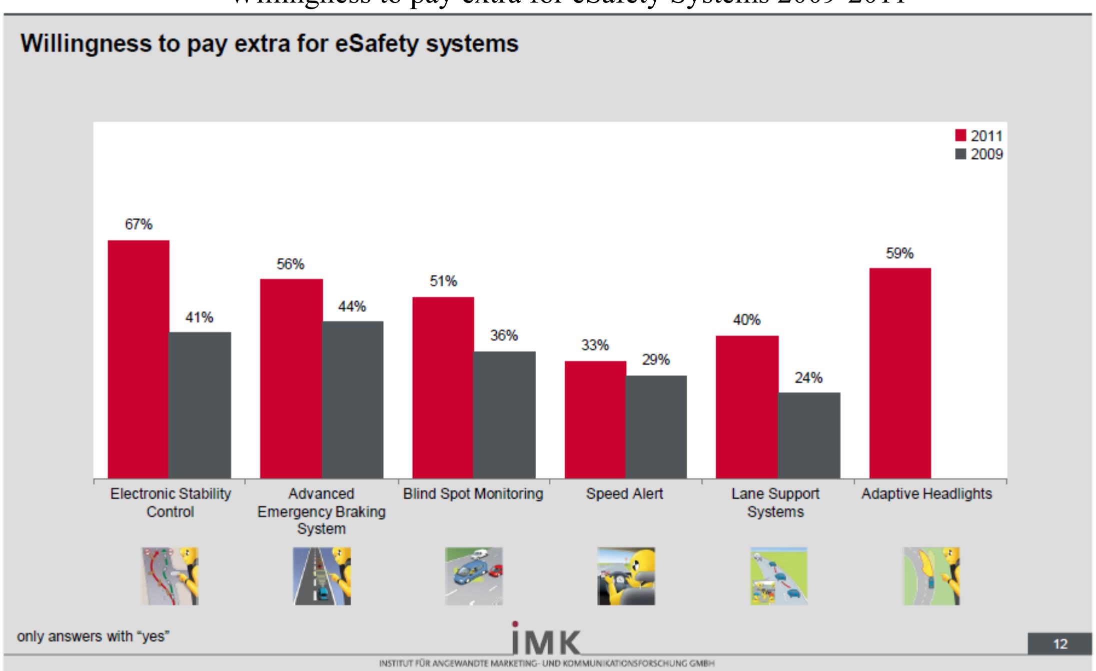


Table 4
Willingness to pay extra for eSafety Systems 2009-2011

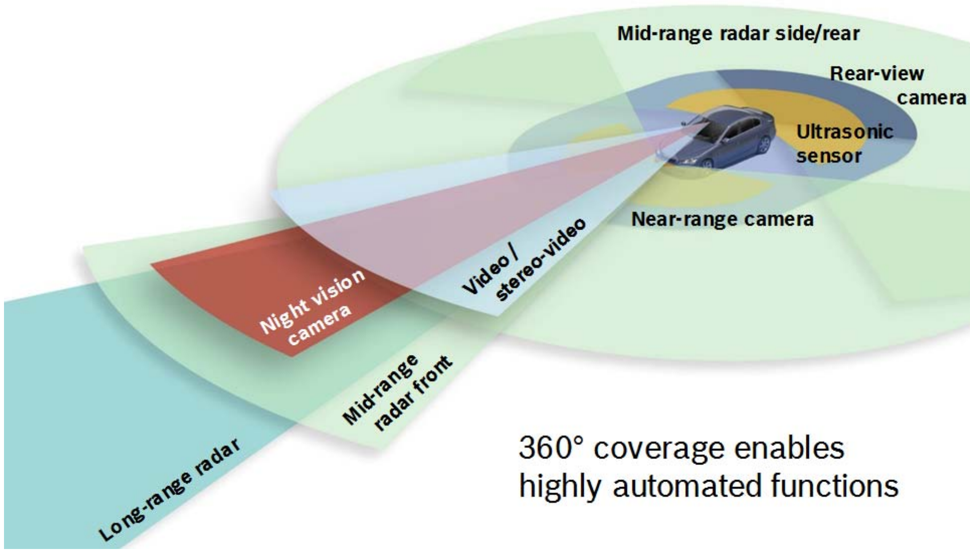


So where to from here? What are the next steps? Is it possible to reach the target of zero accidents set by some automotive companies and agencies?

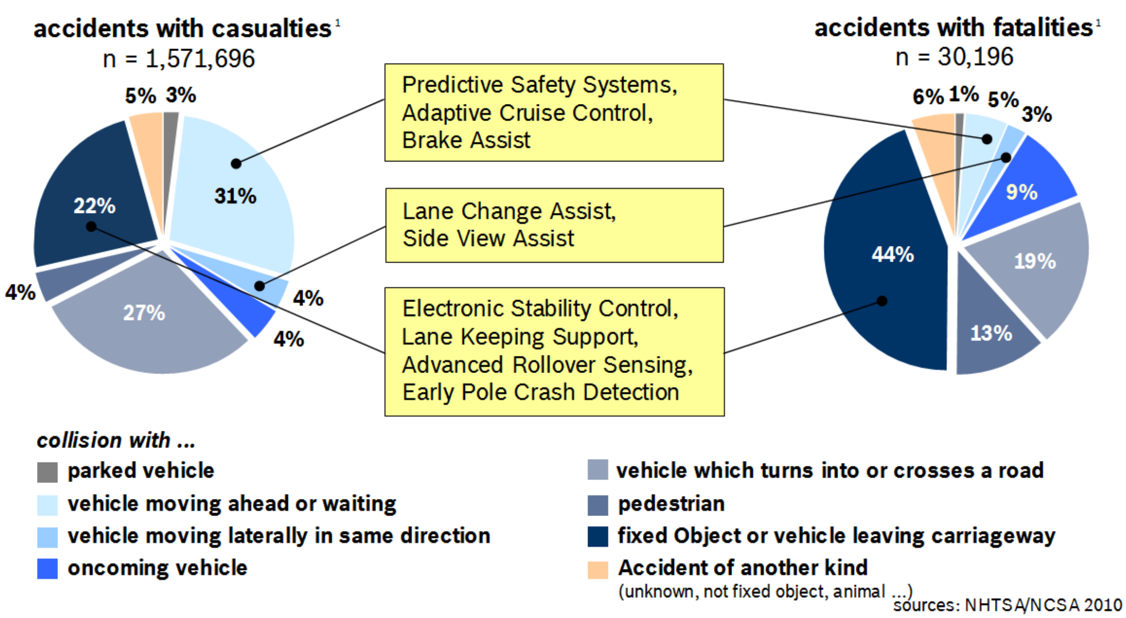
Technology is progressing at a rapid pace as can be seen by the various autonomous vehicles in development and being road tested already in the USA and in Germany. Embedded in these experimental vehicles is a new level of networking of existing and developing technologies that bring together the various vehicle components and meld them with road side infrastructure, digital communication technology and artificial intelligence.

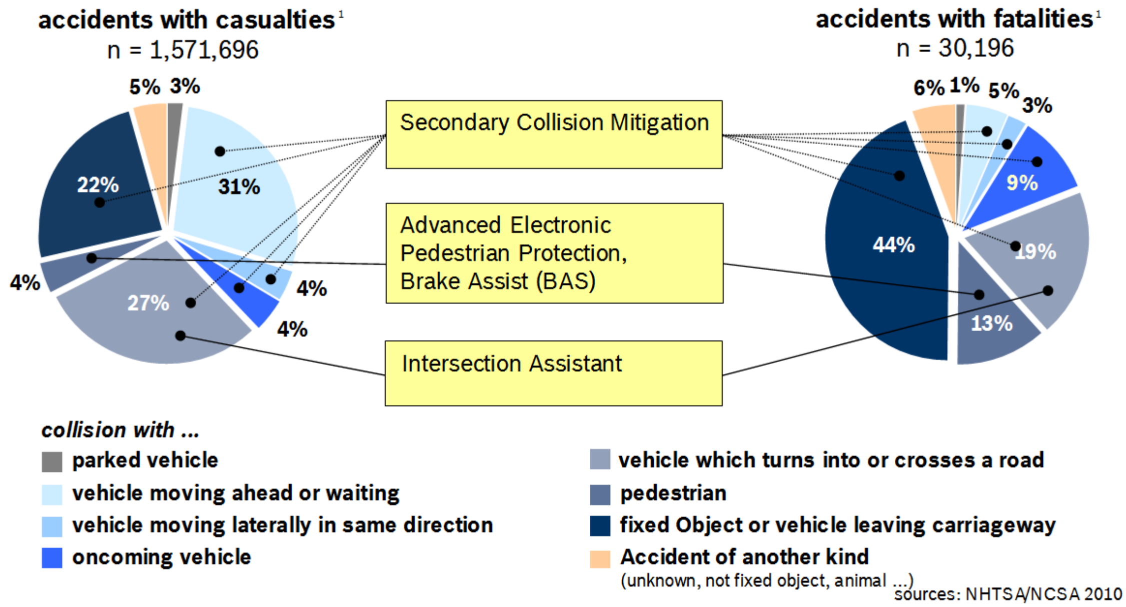
Table 5

Full Surround Sensing Capability



Already full surround sensing capability is available. By networking this near-field situational understanding of the vehicle with the already standard features such as ESP and Electric Power Steering we are now able to better target particular areas of road user vulnerability. By analysing carefully the types of accidents that have occurred, in this case in the USA (Tables 6 & 7), we are now able to focus on what particular life-saving technologies will assist in improving outcomes in various accident scenarios.





To date these experimental autonomous vehicles have limited capability because the infrastructure side of the total system is not yet available. But this is also being developed. Field tests of technology the connects vehicles to other vehicles and road side infrastructure, known as car2X technology, are being run in Germany and the USA. In the Frankfurt-Rhine-Main area of Germany a field test called simTD was conducted during the last quarter of 2012. The purpose of the field test was primarily to investigate how new car2X technology can support both road safety and traffic efficiency. Information was exchanged between test vehicles, and between road users and traffic, road users were notified of potentially dangerous situations to enable them to react in time and appropriately, and support was provided to road users in adapting their routes to avoid a hazard altogether.
A similar test was developed and implemented around the Ann Arbor area in Michigan, USA. The Connected Vehicle Safety Pilot Model Deployment Program is the world’s largest real-world test of DSRC (Dedicated Short Range Communication) based connected vehicle communication technology with approximately 3,000 vehicles operating on public streets in Ann Arbor, MI, USA, for a period of one year (August 2012 to August 2013).
These trials are now running and will aid all interested agencies and companies in making informed decisions about technology implementation and the potential benefits both economically and socially.
Currently these two aforementioned road trials only provide information and warning. But once they are networked with the active and passive safety systems within the vehicles, in a manner similar to the aims of the experimental autonomous driving vehicles, it will be ultimately possible to remove the human error factor from the road, to avoid each other autonomously and bring about the end target of zero accidents.

A further topic often neglected when discussing the introduction of new technology is the need to maintain that same technology. The modern motor vehicle may have dozens of electronic control units and sensors engineered into the vehicle that are almost impossible for any home mechanic to maintain. The interconnectivity of even more complex new systems requires a level of knowledge such that the vehicle manufacturers have complete departments

devoted to what initially appear to be simple topics such as vehicle electrical architecture and inter-connectivity.
To ensure that the benefits gained through new technology and the networking of all of these systems is always available, we need also to pay attention to the maintenance regime required for all these complex systems. No longer is a visual inspection of the basic mechanical components of a car such as suspension, brakes and tyres sufficient to certify that a vehicle is roadworthy. General vehicle maintenance and road worthiness needs to be thought about in a different way, but it doesn't need to be necessarily expensive or onerous.
Fortunately the new safety systems referred to earlier in this paper are also being designed with built in self-diagnostic features. They are able to analyse and process information for internal decision making, cross-check it with other inputs and judge the plausibility of it all. If anomalies are found then the system generally has the ability to either continuing working with reduced capability, or to shut itself down whilst warning the driver and registering a fault code.
More often than not within the vehicle itself such actions are usually the result of sensors or connections that operate and exist in a relatively harsh environment outside of a vehicle's passenger compartment. What this means is that the diagnosed fault can often be easily rectified with the replacement of a simple component.

Conclusion

There are billions of dollars to be saved by reducing road trauma and it is clear that as the public's awareness of the various safety systems increases so does its willingness to pay for those systems, particularly so for those who have previously been involved in accidents or near misses. It is also clear that technology is continuing to move forward at a rapid pace and it will be possible to purchase networked autonomous driving vehicles within the next 10 years. We know that Australia has one of the most diverse vehicle fleets in the world with our vehicles originating from more than a dozen different countries and built to varying standards of quality and safety.

Australia now needs to embrace and invest in the new technologies that build upon ESC in vehicles and that allow cars to be reliably inter-connected with each other and roadside infrastructure. Ultimately this will aid us all in reducing road vehicle accident rates and severity thereof.

Recommendations

1. Road safety industry bodies to encourage government investment in developing new car2X infrastructure technology to support intelligent transport systems.
2. Set minimum ANCAP safety standards for vehicles allowed to be sold in Australia
3. Develop new standards for vehicle maintenance and road worthiness that include Safety System fault checks.
4. Invest in training and tools for the maintenance of the modern vehicle fleet.