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ATSB RESEARCH AND ANALYSIS REPORT

ROAD SAFETY

RESEARCH GRANT REPORT – 2007-02

Intelligent Transport Systems to Support Police Enforcement of Road Safety Laws

Kristie L. Young
Michael A. Regan

Monash University Accident Research Centre

April 2007

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Abstract

Police enforcement of Road Rules and Regulations involves a wide range of complex tasks, many of which demand the use by Police of modern technologies (e.g., fixed and mobile speed detection devices). The aim of this project was to identify and define, from first principles, Intelligent Transport Systems (ITS) and telematics technologies which have significant potential to enhance the effectiveness and efficiency of Police enforcement activities in Australia. Telematics technologies allow the transmission of information via computers and wireless telecommunications technology, and are used in applications such as vehicle tracking systems, on-line vehicle navigation and information systems, and electronic toll collection. The project was undertaken in three stages: identification of those Victorian Road Rules and Regulations that are safety-critical; identification of the tasks currently undertaken by the Victorian Police in carrying out these safety-critical enforcement activities; and identification of suitable ITS and telematics technologies that either currently exist, or could be brought together, to support and optimise the conduct of Police enforcement activities. A number of new and existing ITS and telematics technologies that can be used to support Police traffic enforcement were identified. These technologies have the potential to enhance traffic enforcement by providing practical support to police and encouraging drivers to comply with traffic laws. A number of challenges and issues associated with the use of automated enforcement technologies are discussed.

Keywords

Intelligent Transport Systems; Police; Enforcement; Road Safety; Road Laws; Telematics

Notes

(1) ATSB reports are disseminated in the interest of information exchange.
(2) The views expressed are those of the authors and do not necessarily represent those of the Australian Government or the ATSB.

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EXECUTIVE SUMMARY

Introduction

Police enforcement of road rules and regulations involves a wide range of complex tasks, many of which demand the use by Police of modern technologies (e.g., fixed and mobile speed detection devices). While Police in Australia currently use a number of technologies to support their enforcement activities there now exists an increasingly wide range of Intelligent Transport System (ITS) and "telematics" technologies that have significant potential to further enhance the effectiveness and efficiency of Police traffic enforcement activities. Telematics technologies allow the transmission of information via computers and wireless telecommunications technology, and are used in applications such as vehicle tracking systems, on-line vehicle navigation and information systems, and electronic toll collection

The aim of this project was to identify and define, from first principles, ITS and telematics technologies which have significant potential to enhance the effectiveness and efficiency of Police enforcement activities in Australia. The underlying philosophy of the project was to define high priority operational enforcement problems in need of a technological solution rather than to identify existing and emerging ITS technologies in search of a problem. The project focused on the enforcement of those road rules and regulations that are safety-critical (e.g., those relating to speeding and drink driving) and those rules that Police currently have difficulty enforcing. Only traffic enforcement activities conducted in the Australian state of Victoria were examined as part of the project. The project was undertaken in three stages:

Stage 1: Identification and documentation of the various categories of traffic safety-critical Police enforcement activities currently undertaken in Victoria.

This phase involved identifying those Victorian Road Rules and Regulations that are safety-critical; that is, those rules and regulations that, if more optimally enforced, could lead to significant reductions in road trauma.

Stage 2: Identification of the tasks currently undertaken by the Victorian Police in carrying out these safety-critical enforcement activities.

The aim of this phase was to identify, through a focus group with Police officers, which road rules and regulations Police currently find difficult to enforce and the reason(s) why they find them difficult to enforce (e.g., because they do not have the human, financial or technical resources to enforce them).

Stage 3: Identification of suitable ITS and telematics technologies that either currently exist, or could be brought together, to support and optimise the conduct of Police enforcement activities.

During this phase a review of traffic enforcement technologies that are currently used by Police was undertaken and new and existing ITS technologies that could be used or modified to support and enhance Police traffic enforcement activities were identified through a workshop involving ITS experts and the Victorian Police. Specifically, the project focused on identifying ITS technologies that are capable of supporting and/or enhancing the enforcement of those road rules that Police currently have difficulty enforcing because they do not have the human, financial or technical resources to do so. Several classes of ITS technologies were identified and examined during this phase: those technologies that are used to prevent drivers from engaging in illegal driving behaviours in the first place and those technologies that support the enforcement of those road rules that have already been broken by drivers. Further, in-vehicle, infrastructure-based and cooperative technologies were identified.

Stage 1: Identification of safety-critical road rules

Stage 1 of the project was concerned with the identification and documentation of the various categories of safety-critical Police traffic enforcement activities currently undertaken in Victoria. This involved identifying those Victorian Road Rules and Regulations that are safety-critical; that is, those rules and regulations that, if better enforced, could lead to significant reductions in road trauma.

A number of documents were examined to determine the safety-critical road laws that exist in Victoria. These documents included the Victorian Road Rules (1999); the Road Safety (Road Rules) Regulations 1999; the Road Safety (General) Regulations 1999; the Road Safety (Drivers) Regulations 1999; the Road Safety (Vehicles) Regulations 1999; and the Road Safety Act 1986.

A meeting was held at MUARC involving three MUARC road safety researchers and a Superintendent from the Victoria Police Traffic Support Division to identify the safety-critical road laws. A particular road rule or regulation was deemed safety-critical if the meeting members agreed that Police enforcement of the rule or regulation would lead to a reduction in road trauma. In most cases, the agreement to deem a rule as ‘safety-critical’ was based on previous research findings demonstrating the effectiveness of particular enforcement campaigns in reducing fatal and serious injury crashes and also on the severity of the penalty for violating each rule (e.g., it was broadly assumed that the higher the penalty, the more dangerous is the violation of the rule).

Using this process, a large number of road rules and regulations were identified as safety-critical. The list included 183 rules and regulations, divided into 17 categories. These 17 categories and a brief description of the rules contained in each are contained in the Appendix. These 17 road law categories and their associated rules and regulations were examined in Stages 2 and 3 of the project to determine which of the safety-critical rules and regulations Police currently have difficulty enforcing, and why, and to identify any new or existing ITS technologies that could be used to optimise the enforcement of these road laws.

Stage 2: Enforcement of safety-critical road rules

During Stage 2 of the project, a focus group was held that involved four Police members from the Victorian Police Traffic Support Division as participants. The aim of the focus group was to obtain information on how Police currently enforce each of the 17 categories of safety-critical road rules and regulations identified in Stage 1 of the project and to identify any safety-critical road rules that Police currently have difficulty enforcing and why they find these rules difficult to enforce (e.g., lack of resources).

The four Police members that attended the group had a mean age of 47.5 years (SD = 5.3) and had an average of 14.5 years (SD = 4.9) experience in the Traffic Support Division. The Police members were from both metropolitan and rural areas.

A focus group discussion guide containing a series of pre-defined questions regarding traffic enforcement was used during the focus groups to facilitate the discussion. The participants were first asked a series of specific questions about each of the 17 categories of safety critical road laws (e.g., do you currently have any difficulties enforcing speed-related road rules?). After each of the 17 road rule categories had been discussed, the participants were asked a series of general questions regarding their opinion on the use of technology to assist traffic enforcement.

The results of the focus group revealed that traffic enforcement is a multi-stage process involving detection, interception, and processing of the infringement notice. In some cases, providing evidence of the offence in court is also required. The Police members identified a number of difficulties they experience when enforcing the road rules and regulations. Briefly, the Police members stated that they do not experience difficulty in *detecting* violations of most of the road rules. However, much of this detection is based on visual observation and requires that the Police are in the right place at the right time to observe the violation. Thus, the majority of traffic violations are likely to go undetected because the Police do not have the resources to cover all areas of the road network. Technologies (e.g., Closed Circuit Television) that could be used to detect certain violations without the Police having to be present could prove useful. The members reported that they sometimes experience difficulty *intercepting* vehicles and, in particular, motorcycles and heavy vehicles on busy roads.

In addition, the focus group members reported that they spend a large proportion of their on-duty hours completing paperwork to process infringement notices and that the use of automated enforcement technologies could, paradoxically, increase this paperwork further. Technologies or software that could be used to automate the infringement processing procedure should also be identified to avoid the possibility of overloading traffic Police with more paperwork. Finally, the members stated that proving in court that a violation occurred can be very difficult and, in the absence of photographic or video evidence, it often comes down to a case of the Police member's testimony against the driver's. The members noted that in-vehicle video cameras (soon to be introduced in Victoria) will provide them with video recordings of motorists committing traffic violations, which can then be used as evidence if the driver contests the infringement. The members reported that other enforcement technologies should also be capable of providing photographic or video evidence of traffic violations.

The Police members held positive attitudes towards the use of technology to assist traffic enforcement. They noted, however, that one of the most important features required of enforcement technology is that it needs to provide visual evidence that an offence has occurred. That is, enforcement technologies need to be capable of corroborating Police testimony with photographic or video evidence of an offence. The members also stated that any technology used for traffic enforcement purposes needs to be reliable, accurate under a range of conditions and be quick and easy to set-up and use.

Stage 3: ITS and telematics technologies to optimise police traffic enforcement

Stage 3 of the project aimed to identify new and existing ITS and telematics technologies that could be used to optimise Police enforcement of traffic laws, with a particular emphasis on identifying technologies to assist the enforcement of those road rules that Police currently have difficulty enforcing. There is a wide range of ITS technologies that either exist or are under development that could be used by Police to further support and enhance their enforcement of safety-critical road rules. These technologies could be used in their current form or could be modified or brought together to enhance Police enforcement of those road rules that they already enforce and to support the enforcement of those rules that they have difficulty enforcing. These ITS and telematics technologies were identified through a review of relevant ITS literature and ITS websites, and also an ITS workshop involving a group of ITS and telematics experts from a range of areas, including research, policy and industry (e.g., telematics suppliers).

The use of automated enforcement technologies is becoming increasingly popular both in Australia and overseas and Traffic Police around the world currently use a range of traffic enforcement technologies. These include fixed and mobile speed cameras, red-light cameras, combined speed and red-light cameras, alcohol ignition interlocks, heavy vehicle data loggers and automatic licence plate recognition systems. The use of automated enforcement technologies can improve the effectiveness, accuracy and efficiency of police traffic enforcement activities by increasing the actual and perceived chance of traffic violations being detected without increasing the number of police resources required (Falkerson, 2003; PACTS, 2005; Pilkington & Kinra, 2006). Automated enforcement also has a number of other benefits over traditional enforcement measures including providing evidence (e.g., photographic) that a violation has been committed and by simplifying the process of producing infringement notices (Zaal, 1994).

The review of the literature and the ITS workshop identified a number of new and existing ITS and telematics technologies that can be used to support Police traffic enforcement. The technologies identified included in-vehicle, infrastructure-based and cooperative systems; systems that would both prevent drivers from engaging in illegal driving behaviours and support the enforcement of those road rules that have been violated.

Conclusions

Traffic enforcement is a multi-dimensional issue involving not just detection of traffic violations, but also interception of offending drivers, processing of infringements and, in some instances, providing evidence that an offence occurred. New and existing ITS and telematics technologies have been identified that can support Police traffic enforcement at each of these levels and also help prevent drivers from committing traffic violations in the first place.

While ITS and telematics technologies have the potential to enhance the effectiveness of Police traffic enforcement activities, there are a number of challenges that need to be addressed before many of the identified technologies can be implemented. Many of these challenges relate to the development and installation of infrastructure, databases and support agencies required for the systems to operate effectively. Also, issues relating to the acceptability to road users of enforcement technologies, particularly those technologies that are purchased by consumers, will need to be examined and addressed. Finally, extensive testing would need to be carried out for any enforcement technology prior to deployment to ensure it poses no safety risks to road users.

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We also thank the members of the Stage 3 workshop for their input in identifying relevant ITS technologies that may be used to enhance Police traffic enforcement.

Finally, we wish to thank Karen Stephan and Megan Bayly from the Monash University Accident Research Centre for their assistance in the early stages of the project.

1 INTRODUCTION

1.1 Project aims and phases

Police enforcement of the Road Rules and Regulations involves a wide range of complex tasks, many of which demand the use of modern technologies (e.g., fixed and mobile speed detection devices). While Police in Australia currently use a number of technologies to support their traffic enforcement activities, there now exists an increasingly wide range of Intelligent Transport System (ITS) and 'telematics' technologies which have significant potential to further support and optimise the effectiveness and efficiency of Police enforcement.

The terms ITS and vehicle telematics refer to advanced computer, communications, sensor and control technologies applied to transport. While some argue that ITS and vehicle telematics are two separate categories of technologies - with ITS being broader in scope than telematics - the distinction between the two is becoming increasingly blurred and, indeed, the terms are now often used synonymously. ITS and telematics technologies are capable of addressing various transportation problems: improving travel efficiency and mobility, enhancing safety, conserving energy and protecting the environment. ITS technologies have been installed both in vehicles and in the road infrastructure. An example of an in-vehicle ITS technology is satellite navigation systems, while electronic tolling systems are an example of a cooperative ITS.

The technologies that exist to support the enforcement of traffic laws include Global Positioning Systems (GPS), sensor, control and information and communications technologies of various kinds. For example, ITS technologies currently exist that, when integrated, could automatically warn Police, via an in-car display, of the location of a vehicle driven by an unlicensed driver (or a driver not endorsed to drive in that location or at that time) and enable the Police officer to electronically issue an infringement notice to that driver. Similarly, there is mounting evidence, on road safety grounds, to support a ban on the use of hands-free mobile phones while driving. However, there is currently no practical means of enforcing such a ban. ITS technologies exist, however, that could make it impossible for drivers to engage in hands-free mobile phone discussions while driving.

The aim of the current project is to identify and define ITS and telematics technologies which have the potential to enhance the effectiveness and efficiency of Police enforcement activities in Australia. The project focused on the enforcement of those road rules and regulations that are safety-critical (e.g., those relating to speeding and drink driving) and those rules that Police currently have difficulty enforcing. Only traffic enforcement activities conducted in the Australian state of Victoria were examined as part of the project. The project was undertaken in three stages:

Stage 1: Identification and documentation of the various categories of traffic safety-critical Police enforcement activities currently undertaken in Victoria.

This phase involved identifying those Victorian road rules and regulations that are safety-critical. That is, those rules and regulations that, if better enforced, could lead to significant reductions in road trauma.

Stage 2: Identification of the tasks currently undertaken by Victorian Police in carrying out these safety-critical enforcement activities.

The aim of this phase was to identify, through a focus group with Police officers, which road rules and regulations Police currently find difficult to enforce and the reason(s) why they find them difficult to enforce (e.g., because they do not have the human, financial or technical resources to enforce them).

Stage 3: Identification of suitable ITS and telematics technologies that either currently exist, or could be brought together, to support and optimise the conduct of Police enforcement activities.

This phase involved a review of traffic enforcement technologies that are currently used by Police and the identification of new and existing ITS technologies that could be used or modified to support and enhance Police traffic enforcement activities. Specifically, the project focused on identifying ITS technologies that are capable of supporting and/or enhancing the enforcement of those road rules that Police currently have difficulty enforcing because they do not have the human, financial or technical resources to do so. Two classes of ITS technologies were identified and examined during this phase: those technologies that are used to prevent drivers from engaging in illegal driving behaviours in the first place and those technologies that support the enforcement of those road rules that have already been broken by drivers.

1.2 Structure of the report

This report presents the aims, methods and outcomes of the project. Chapter 2 presents the outcomes of Stage 1 of the project, which was concerned with the identification and documentation of the various safety-critical road rules and regulations in Victoria. The Stage 2 focus group results, which identified those road rules and regulations that police currently have difficulty enforcing, are presented in Chapter 3. Chapter 4 reviews current automated enforcement technologies used by police in Australia and overseas to enforce traffic laws. Chapter 5 presents and discusses the new and existing ITS and telematics technologies, identified during the workshop and literature searches, that can be used, developed or modified to optimise police enforcement of current Victorian road rules and regulations. Finally, Chapter 6 provides a discussion of the results of the project and some issues associated with automated traffic enforcement.

2 AUSTRALIAN AND VICTORIAN ROAD RULES AND REGULATIONS

2.1 Identification of Safety-critical road laws

Stage 1 of the project was concerned with the identification and documentation of the various categories of safety-critical Police traffic enforcement activities currently undertaken in Victoria. This involved identifying those Victorian Road Rules and Regulations that are safety-critical; that is, those rules and regulations that, if better enforced, could lead to significant reductions in road trauma.

A number of documents were examined to determine the safety-critical road laws that exist in Victoria. These documents included the Victorian Road Rules (1999); the Road Safety (Road Rules) Regulations 1999; the Road Safety (General) Regulations 1999; the Road Safety (Drivers) Regulations 1999; the Road Safety (Vehicles) Regulations 1999; and the Road Safety Act 1986.

A meeting was held at MUARC involving three MUARC road safety researchers and a Superintendent from the Victoria Police Traffic Support Division to identify the safety-critical road laws. A particular road rule or regulation was deemed safety-critical if at the meeting members agreed that Police enforcement of the rule or regulation would lead to a reduction in road trauma. In most cases, the agreement to deem a rule as ‘safety-critical’ was based on previous research findings demonstrating the effectiveness of particular enforcement campaigns on reducing fatal and serious injury crashes and also on the severity of the penalty for violating each rule (e.g., it was assumed that the higher the penalty, the more dangerous is the violation of the rule). Using this process, a large number of road rules and regulations were identified as safety-critical. The number of rules and regulations was too large to be discussed in any depth during the Stage 2 focus group with Police members and the Stage 3 ITS workshop. Hence, the rules were further prioritised into those that were ‘most’ safety-critical. The criteria used to further refine the list of safety-critical road laws were: those rules and regulations that were likely to lead to the greatest reductions in road trauma; those rules that would be better enforced with the use of ITS; and those rules and regulations that are violated most frequently. For example, it was agreed that violation of Road Rule 289 – “Driving on a nature strip” is likely to occur less frequently than other traffic violations, such as speeding; is likely to have less severe safety consequences than, say, drink driving; and that the enforcement of this rule is less likely than many other road rules to be enhanced by the use of ITS. This road rule was therefore not included on the final list of safety-critical rules.

2.2 Summary of safety-critical road laws

The list of safety-critical road rules and regulations that was examined in the subsequent two stages of the project included 183 rules and regulations and was divided into 17 categories. These categories and a brief description of the rules contained in each are contained in this section. The full list of the 183 safety-critical road rules and regulations that were identified during Stage 1 of the project are contained in Appendix A.

1. **Speeding:** This category contains 5 rules relating to the requirement for drivers to obey posted speed limits along the stretch of road they are travelling and to obey variable speed limit signs in school, shared and speed-limited zones.

2. **Driving Under the Influence of Alcohol and Other Drugs:** This category contains 4 Sections from the Road Safety Act 1986 relating to driving with a Blood Alcohol Concentration (BAC) above the legal or prescribed limit and driving or being in charge of a vehicle while impaired by another drug.

3. **Seatbelt Wearing:** This category contains 3 rules relating to the requirement for drivers and passengers to wear seatbelts while the vehicle is moving and stationary, but not parked.

4. **Giving Way:** This category contains 31 rules relating to the need for drivers to give way to other road users when at a Stop or Give Way sign, at unsignalised intersections and roundabouts, when making a U-turn, entering a road, changing lanes or merging, when at a level crossing or a pedestrian crossing or when passing trams or buses, and to give way to emergency vehicles.

5. **Turning and Signalling:** This category contains 14 rules regarding how to correctly make left and right-hand turns, hook turns and U-turns from single and multi-lane roads, and the requirement to give appropriate turning and stopping signals using the vehicles indicators or hand signals.

6. **Lane Keeping:** This category contains 9 rules related to the requirement for drivers to drive on the left-most side of the road, stay within a single lane unless changing lanes or merging, complying with overhead lane control devices and to not drive in bicycle lanes.

7. **Overtaking:** This category contains 5 rules relating to safe overtaking practices, including requirements that drivers must not overtake unless safe to do so, must not overtake a vehicle turning right or a vehicle displaying a "do not overtake" sign and, when being overtaken, must not increase their speed.

8. **Keeping a safe following distance:** This category contains 2 rules relating to keeping a safe distance behind vehicles.

9. **Obeying traffic signals and signs:** This category contains 28 rules relating to the requirement for drivers to obey traffic light signals, and obey traffic signs, including no overtaking or passing signs, no entry and keep clear signs, hand-held signs, and large vehicle signs (e.g., no trucks or buses signs).

10. **Illegal stopping and parking:** This category contains 13 rules relating to not stopping in or near intersections, level crossings, bus zones, special vehicle lanes, safety zones, on bridges or in tunnels, or on a crest or curve in the road. The category also contains rules regarding not double parking and how to safely enter and exit a median strip parking area.

11. **Use of technology in vehicles:** This category contains 2 rules regarding the restrictions on drivers using hand-held mobile phones and visual display units while driving.

12. **Careless/Reckless Driving:** This category contains 4 Sections from the Road Safety Act 1986 relating to the requirement for drivers not to drive in manner that is dangerous to the public, in a careless manner, or engage in street speed races or trials. This category also contains a section relating to the requirement for pedestrians and bicyclists to not use any part of a freeway.

13. **Licensing and Registration:** This category contains 22 rules regarding the requirement for drivers to appropriately affix number plates to vehicles, not use false or altered number plates, display appropriate vehicle registration, not drive unregistered vehicles, not drive if unlicensed or disqualified from driving and to observe the conditions/restrictions of their licence including vehicle power restrictions. This category also contains a section on the obligations of insurers, motor wreckers and car traders to report written-off vehicles.

14. **Towing and Loads:** This category contains 6 rules and regulations regarding keeping control of a vehicle being towed, obligations when towing a vehicle at night or in hazardous conditions, properly securing any load being towed, and keeping towed vehicles within mass, dimension and height limits.

15. **Heavy vehicles – Mass dimensions and driving hours:** This category contains 15 regulations regarding adhering to heavy vehicle mass and dimension limits, adhering to the prescribed heavy vehicle driver driving and rest hours and complying with the requirement that all vehicles over 14.5 tonnes and built after 1987 must be speed limited.

16. **Bicyclists and Motorcyclists:** This category contains 10 rules regarding the requirement for bicyclists and motorcyclists to wear helmets, and for bicyclists to ride in a designated bicycle lane, obey all bicycle-related signs and signals, and not ride too close to the rear of other vehicles.

17. **Trams and Buses:** This category contains 9 rules regarding the requirement for bus and tram drivers to obey all tram and bus-related traffic signs and signals.

These road law categories and their associated rules and regulations were examined in Stages 2 and 3 of the project to determine which of the rules and regulations Police do and do not enforce, and why, and to identify any new or existing ITS technologies that could be used to enhance their enforcement.

3 ENFORCEMENT OF ROAD RULES BY VICTORIAN POLICE

3.1 Stage 2 Focus Group

During Stage 2 of the project, a focus group was held at MUARC involving as participants four Police members from the Victorian Police Traffic Support Division. The aim of the focus group was to obtain information on how Police currently enforce each of the 17 categories of safety-critical road rules and regulations identified in Stage 1 of the project and to identify any safety-critical road rules that Police currently have difficulty enforcing and why they find these rules difficult to enforce (e.g., lack of resources).

At the commencement of the group, the participants were provided with information about the aims of the project and what ITS technologies are. Participants then completed a short demographics questionnaire to obtain information on their age and years with the Traffic Support Division (a copy of the demographics questionnaire is contained in Appendix A). A focus group discussion guide containing a series of pre-defined questions regarding traffic enforcement was used during the focus groups to facilitate the discussion (see Appendix B for a copy of the discussion guide). The participants were first asked a series of specific questions about each of the 17 categories of safety-critical road laws (e.g., how do you currently enforce speed-related road rules?). Each of these categories and their associated rules and regulations were set out in a PowerPoint document so that they could easily be viewed by all participants while they were answering the specific questions. After each of the 17 road rule categories had been discussed, the participants were asked a series of general questions regarding traffic enforcement and the use of technology to assist enforcement of the road rules.

The four Police members that attended the group ranged in age from 42 to 53 years (Mean age = 47.5, SD = 5.3 years) and had an average of 14.5 years (SD = 4.9) experience in the Traffic Support Division. The Police members were from both metropolitan and rural areas.

3.2 Focus Group Results

In this section, the results of the focus group discussion are presented and discussed. The findings are first presented for each of the 17 road rule categories separately and the findings from the general questions are then discussed.

3.2.1 Speeding

The Police stated that speed-related road rules are currently enforced using hand-held radar or laser speed detectors, time over distance measures, which obtain measures of average speed over a section of road, and moving mode radar, which is most commonly used in country areas. In addition, speed-related rules are also enforced using fixed speed cameras. The members stated that, overall, they find the current speed detection technologies easy to use and that they provide accurate and reliable measures of vehicle speed. However, the members did state that on-coming headlights at night can affect the accuracy of hand-held laser detectors. Also, the members mentioned that fixed speed cameras identify speeding vehicles not the driver of the vehicle. Thus, owner onus applies in identifying who was actually driving the vehicle at the time of the speed infringement.

In general, the members stated that they have no difficulty in detecting speed-related offences. However, they do find intercepting speeding vehicles, particularly motorcycles, difficult, particularly if the Police are in a stationary vehicle when they detect the speeding vehicle. Police most commonly intercept vehicles by moving out into the traffic and catching up to the speeding vehicle. This requires the Police to sometimes travel at high-speeds in order to catch up to the vehicle, particularly if they are in rural areas. In low speed areas, Police are sometimes able to manually wave down drivers from the side of the road. Alternatively, the Police can radio to a Police vehicle stationed a distance up the road to pull over a particular vehicle. This method, however, is resource intensive as it requires at least two units to detect and intercept each speeding vehicle. The members noted that the use of moving mode radar does assist with the interception of speeding vehicles because they can detect speeding motorists while already moving through the traffic rather than having to initiate an interception from a stationary vehicle. The members also mentioned that the use of an immobiliser to stop speeding vehicles would assist the interception of vehicles in theory, but that this would have to be tested thoroughly before being implemented.

Although the members stated that they generally find the speed-related road rules easy to enforce, they did state that they currently have difficulty enforcing Road Rule 23 – speeding in school zones. The members identified two reasons for this difficulty. The first reason relates to the definition of school zones. For school zones extending across a number of intersections, it is difficult for the Police and motorists to determine where the zone ends if there are not repeater speed signs placed after each intersection. The second, and more relevant, reason relates to the length of school zones. At present, it is difficult for Police to obtain, using radar and laser speed detectors, an accurate speed reading of vehicles in school zones of less than 500 metres in length. A number of school zones are less than 500 meters long, so it is difficult for Police to obtain an accurate speed reading in these instances.

3.2.2 Driving Under the Influence of Alcohol and Other Drugs

Alcohol and drug-related road rules are currently enforced using random roadside breath and saliva testing usually using “booze” and drug buses. Drivers are given a preliminary breath test in the case of alcohol testing, or a preliminary saliva test, in the case of drug testing. If drivers test positive to illicit drugs or are above the allowable alcohol limit on these preliminary tests they then undergo a series of impairment tests, videotaped interviews and are required to give an oral fluid or blood test. The Police members stated that they have little difficulty in detecting alcohol and drug use among drivers and believe that the preliminary breath and saliva tests are accurate at detecting the presence and level of alcohol or illicit drugs.

The Police members, however, stated that they find the process of alcohol and, in particular, drug enforcement complicated and the timelines often too stringent. Once a driver tests positive to illicit drugs or alcohol, the Police are required to carry out the impairment tests, videotaped interviews and obtain a blood sample within 3 hours of the preliminary breath or saliva testing. They are then required to forward to the Traffic Alcohol Section (TAS) the videotapes and blood samples within 24 hours for analysis and a brief on the offence within 1 week. The members noted that these timelines are very tight and are often unfeasible. Thus, it is not the initial testing and detection of drink and drug driving offences that Police have difficulty with, but the process undertaken to obtain and analyse the blood or oral fluid samples and process the offence.

3.2.3 Seatbelt Wearing

The Police members stated that they currently detect non-seatbelt use through visual observation. They stated that, while driving, they are constantly scanning the traffic for traffic violations including vehicle occupants not wearing their seatbelt. The members generally look for the seatbelt buckle on the side pillar of the car to determine seatbelt use because this is the most obvious sign that occupants are not restrained. Overall, the members stated that they do not have any difficulty in detecting or enforcing non-seatbelt use; although they did state that tinted windows and driving at night can make it difficult to detect if car occupants are unrestrained.

3.2.4 Giving Way

Traffic violations involving a driver failing to give way to another road user are typically enforced as a result of a crash. For instance, if Police establish that a failure to give way was a major contributing factor in the crash, then they will issue an infringement notice as appropriate. Giving way violations are also enforced through visual observation, which the Police undertake as part of their patrol activities. This requires that the Police are in the right place at the right time to observe the offence. Finally, the Police may receive complaints from the public regarding a high number of giving way violations at a particular intersection or pedestrian crossing. The Police will then target this intersection for a period of time in order to enforce the giving way rules.

The Police stated that they do not have any difficultly in detecting or enforcing giving way rules. However, they can only enforce those violations that they happen to observe while on patrol or that they receive complaints about. In addition, the members stated that they have difficultly enforcing Road Rule 78 – Keeping clear of Police and emergency vehicles – because violations of this rule occur when they are responding to an emergency and they do not have time to stop and issue the offending motorist with an infringement notice.

The members highlighted that technologies such as in-vehicle video cameras in the Police vehicles and red light cameras installed at level crossings would assist the enforcement of giving way behaviour and provide visual evidence of the offence in the event that a motorist contests a giving way infringement notice.

3.2.5 Turning and Signalling

As with giving way behaviour, incorrect or illegal turning manoeuvres or failure to signal when turning or stopping are detected and enforced either as a result of a crash or through visual observation or complaints from the public. While the members stated that they do not have difficulty in enforcing turning and signalling violations, they can only enforce those violations that they observe while on patrol, that are evident from a crash, or that they receive complaints about.

3.2.6 Lane Keeping

The Road Rules relating to lane keeping (e.g., keeping to the left and driving within the marked lane of traffic) are generally enforced through observation while patrolling and the members stated that they are not difficult to detect or enforce. The members did state, however, that drivers will often contest an infringement notice related to lane keeping offences, particularly driving in the right hand lane of a multi-lane road, and it is difficult for the Police to provide evidence in court that the offence occurred. The members stated that in-vehicle video cameras would be helpful in providing visual evidence of the offence in these instances.

3.2.7 Overtaking

Illegal overtaking behaviour is detected and enforced either through Police observation or as a result of a crash where it is established that illegal overtaking was a contributing factor to the crash. Again, the members stated that they do not have difficulty in enforcing overtaking violations, but they can only enforce those violations that they observe while on patrol or that are evident from a crash.

3.2.8 Keeping a safe following distance

The members stated that failure to keep a safe following distance is generally easy to detect, particularly if the gap between the lead and following vehicles is very small. However, they did note that judging following distance can be subjective as it is based on the officers' judgement of distance using the car lengths method, rather than any objective form of measurement. As such, many drivers will argue that they were not tailgating the vehicle ahead and contest the infringement. The members stated again that in-vehicle cameras would be useful for providing evidence of the violation in these instances. They also noted that the cameras would be more useful if they were capable of providing instant playback, so that the Police can demonstrate the violation to drivers on-the-spot, which may in-turn reduce the number of drivers contesting the infringement notice.

3.2.9 Obeying traffic signals and signs

The Police members stated that detecting a traffic light or sign violation is not difficult per se, but that it is impossible for them to detect all of these offences due to a lack of resources – they cannot be stationed at every intersection. The members noted that the use of red light cameras has been of great assistance in enforcing red light running offences and in reducing the incidence of these violations. They also noted that in-vehicle video evidence would be useful for providing visual evidence of the violations that can be used in court.

In addition to the red light cameras, violations of the traffic signals and sign (e.g., stop signs) rules are detected and enforced either through Police observation or complaints from the motoring public. In particular, the Police stated that they receive many complaints regarding drivers not adhering to hand-held signs, such has those at roadworks, because the person holding the sign will write down the number plate of the offending vehicles and report it to Police.

3.2.10 Illegal stopping and parking

Illegal stopping and parking violations are detected and enforced either through visual observation while patrolling or via complaints from the public. The members stated that they typically only enforce illegal parking or stopping violations if they pose a safety risk to other road users (e.g., stopped on a curve in the road) or if they are in a disabled zone. The non-safety critical violations are typically dealt with by the local council. The members stated that they have no difficulty in detecting or enforcing illegal stopping and parking rules because it is usually clear when a vehicle is stopped in a place where it should not be.

3.2.11 Use of technology in vehicles

Hand-held mobile phone use and the use of television and visual display units that are not driver aids (navigation systems, for example, are regarded as drivers aids) in vehicles is currently prohibited under Victorian law. The members noted that there is a lot of confusion regarding what an in-vehicle visual display unit is and when it becomes a driver's aid, and, thus, is legal to use while driving. This however, is more of a legislation issue, than a problem that can be solved with the assistance of technology. The members stated that it is not difficult to detect if drivers are using a visual display or a hand-held mobile phone, because they usually place the display high enough on the dashboard to be visible from outside the vehicle, and many mobile phones have an illuminated display which makes it easy to observe drivers using them. The members also stated that they find it easy to detect if drivers are sending or reading text messages on a mobile phone because they usually rest the phone against the steering wheel which makes it visible from outside the vehicle. Police also look for other signs that drivers may be distracted by a visual display or the mobile phone, such as driving well below the speed limit and swerving out of their marked lane. If the Police observe these driving behaviours they will investigate further to see what the driver is doing to cause them to drive in that manner.

3.2.12 Careless/Reckless Driving

The members stated that they have no difficultly in detecting and enforcing Careless and Dangerous driving rules because it is easy to observe erratic or unsafe driving behaviour. However, this requires that the Police are in the right place at the right time to observe the offence. The Police stated that they also issue infringement notices for these offences as a result of crashes, if it is established that careless or dangerous driving, or drag racing, contributed to the crash.

3.2.13 Licensing and Registration

The members stated that licensing and registration offences are very easy to detect and enforce and that they do this by inputting vehicle details into the mobile data units equipped to the Police vehicles or calling through the vehicle’s details over the radio. They then receive information regarding the registration status of the vehicle and the licence status of the vehicle’s owner.

The members did however note that Road Rule 211, relating to vehicle power restrictions for probationary drivers is difficult to enforce because it is often difficult to obtain the vehicle’s power to weight ratio and driver will sometimes weigh the vehicle down so that it falls into the allowable power restrictions zone.

Drivers with international driver’s licences also make enforcement of licensing restrictions difficult because it is sometimes unclear, particularly with licences written in a foreign language, to what licensing restrictions the driver is required to adhere (e.g., automatic transmission or wearing corrective lenses) and it is often difficult to establish if the licence is still valid. This, however, may be an issue that is better solved with changes to licensing legislation rather than through the use of technology.

3.2.14 Towing and Loads

In regard to the road rules related to towing and loads, the members stated that they typically focus on enforcing those towing rules that have safety consequences, such as the trailer or vehicle being towed being correctly attached to the primary vehicle and the trailer lights and indicators working appropriately. The Police currently detect towing and load violations through visual observation while patrolling and will also issue infringement notices at a crash scene if it is determined that violation of these rules contributed to the crash.

3.2.15 Heavy vehicles – Mass dimensions and driving hours

The members stated that they find heavy vehicle driving hours and mass and dimension limits sometimes difficult to detect and enforce, because it requires them to weigh the vehicle, or establish where the truck has travelled from in addition to examining the driving hours log book. The members also find it dangerous or disruptive to other traffic to intercept a large vehicle on busy roads. Typically, the Road Safety Task Force will enforce heavy vehicle road rules and regulations and will run targeted operations in order to detect and enforce violations of these rules. This means that the Task Force will be equipped with the necessary equipment, such as weigh bridges and log book checkers, to establish if the vehicle has exceeded its mass and dimension limits or the driver has exceeded their maximum number of driving hours.

The members also noted that it is difficult for traffic Police to determine on the spot if the speed limiter has been tampered with or disconnected, as this requires specialist knowledge and equipment. Again, the Road Safety Task Force typically will enforce heavy vehicle compliance with speed limiting restrictions. The traffic Police will, however, issue infringement notices to the drivers of heavy vehicle if they are exceeding their maximum allowable speed limit.

3.2.16 Bicyclists and Motorcyclists

Typically, the Police have little difficulty detecting traffic violations that are specific to bicyclists and motorcyclists and typically do this through visual observation. They do however, have difficulty intercepting these road users and, for bicyclists, establishing their identity because they are not required to carry identification. The members also stated that the majority of bicyclists that they intercept are under the age of 14 years and, hence, they cannot issue them with an infringement notice.

3.2.17 Trams and Buses

The members stated that they very rarely have to enforce the road rules relating to trams and buses obeying specific traffic signals, because these road users only rarely violate these rules. Thus, this category will be excluded from any further discussion in the Stage 3 workshop.

3.2.18 General Discussion Questions

Four general questions were asked at the end of the focus group to extract information regarding Police opinions on the use of technology to help them enforce the road rules and what features of enforcement technology they deem essential. The participants' responses to these questions are outlined below.

1. Are the road rules more or less difficult to enforce with particular road users (e.g., heavy vehicles or motorcyclists)?

The members reported that they find motorcyclists and bicyclists harder to intercept than other vehicles because they, in the case of motorcyclists, can travel faster than cars and weave around traffic. Bicyclists are also more difficult to intercept because they are not required to carry any form of identification and, hence, establishing their correct identify to issue them with an infringement notice can be problematic. The members also stated that the road rules and regulations surrounding heavy vehicle mass and dimension limits can be difficult to interpret and enforce if they do not have the required equipment (e.g., a weigh bridge).

2. Do you think that any of the current road rules are dangerous to enforce?

The members agreed that they do not believe that any of the road rules are dangerous to enforce if they are enforced in the correct manner. However, they do believe that the environments in which they sometimes have to intercept vehicles can be dangerous, such as stopping vehicles in the side of a busy, high-speed road. The members stated that they are mindful of these dangers and will not intercept vehicles unless it is safe for them to do so.

3. How do you feel about using technology to help you enforce certain road rules?

The members held positive attitudes towards the use of technology to assist traffic enforcement. They reported that the current use of speed and red light cameras has reduced speeding and red light running offences and had an impact on the road toll in Victoria. The members also mentioned that enforcement technologies are now much more user-friendly – they are quick and easier to use and set-up and are more accurate and reliable.

In particular, the members reported that they are very favourable towards the use of in-vehicle video cameras to record traffic offences as this will assist them in proving that the offence occurred if the driver contests the infringement.

4. What are the features of enforcement technologies that are most critical to help Police enforce road laws?

The members agreed that one of the most important features of enforcement technology is that it provides visual evidence that the offence occurred. That is, enforcement technologies need to be capable of corroborating Police testimony with photographic or video evidence of an offence. Also, the members stated that any technology used for traffic enforcement purposes needs to be reliable, accurate under a range of conditions and be quick and easy to set-up and use.

The members stated that they do not want all traffic enforcement to become automated as they do not feel that this will be acceptable to the motoring public. They also noted that many drivers question the accuracy and reliability of current enforcement technologies, particularly speed and red-light cameras.

Finally, the members reported that they currently spend a large proportion of their work time completing paperwork to process infringement notices. They raised concern that the use of enforcement technologies may increase the number of traffic offences detected and, in turn, the amount of paperwork they have to do to process these infringements. The members suggested that a software program needs to be developed to automatically process traffic infringements or at least reduce the amount of time it takes the members to process the fines. Given the importance that the members placed on this issue, infringement processing software was included as a category for discussion in the Stage 3 workshop.

3.3 Summary

Traffic enforcement is a multi-stage process involving detection, interception, processing of the infringement notice and, in some cases, providing evidence of the offence in court. Overall, the Police members stated that they do not experience difficulty in *detecting* violations of most of the road rules. However, much of this detection is based on visual observation and requires that the Police are in the right place at the right time to observe the violation. Thus, the majority of traffic violations are likely to go undetected because the Police do not have the resources to cover all areas of the road network. Technologies (e.g., Closed Circuit Television) that could be used to detect certain violations without the Police having to be present could be useful. The members reported that they sometimes experience difficulty when intercepting vehicles and, in particular, motorcycles and heavy vehicles on busy roads. Thus, technologies that could assist Police to intercept vehicles should also be identified.

The members stated that proving in court that a violation occurred can be very difficult and, in the absence of photographic or video evidence, it often comes down to a case of the Police's testimony against the driver's. The members noted that in-vehicle video cameras (soon to be introduced in Victoria) will provide them with video recordings of motorists committing traffic violations which can then be used as evidence if the driver contests the infringement. Other enforcement technologies should also be capable of providing photographic or video evidence of the violations. Finally, the members reported that they spend a large proportion of their time completing paperwork to process infringement notices and that the use of automated enforcement technologies could increase this paperwork further. Technologies or software that could be used to automate the infringement processing procedure should also be identified to avoid the possibility of overloading traffic Police with more paperwork.

Table 1 contains the 17 road rule categories discussed during the focus group and provides a summary of any difficulties Police reportedly experience in enforcing these rules. The stage 3 workshop and literature review will identify new and existing ITS and telematics technologies that could be used to optimise Police enforcement of traffic laws, with a particular emphasis on identifying technologies to assist the enforcement of those road rules that Police currently have difficulty enforcing.

Table 1: Summary of Police traffic enforcement problems

Road Rule Category	Enforcement Problems
Speeding	Difficulty enforcing Road Rule 23 – speeding in school zones because some school zones too short to detect speeding. Difficulty intercepting vehicles in high-speed zones, particularly when Police vehicle is stationary.
Driving Under the Influence of Alcohol and Other Drugs	Procedure of collecting and processing blood samples within the required time frame in the case of drug driving offences is difficult.
Seatbelt Wearing	Difficult to detect unrestrained occupants at night and in cars with tinted windows.
Giving Way	Road Rule 78 – keeping clear of Police and Emergency vehicles – do not have time to stop and enforce this rule. No other enforcement difficulties identified. Detection is, however, largely based on visual observation and the Police being in the right place at the right time.
Turning and Signalling	No particular enforcement difficulties identified. Detection is, however, largely based on visual observation and the Police being in the right place at the right time.
Lane Keeping	No particular enforcement difficulties identified. Detection is, however, largely based on visual observation and the Police being in the right place at the right time.
Overtaking	No particular enforcement difficulties identified. Detection is, however, largely based on visual observation and the Police being in the right place at the right time.
Keeping a safe following distance	The judgement of following distance is subjective. Have no objective evidence that the offence occurred.
Obeying traffic signals and signs	Impossible to detect all traffic signal offences due to lack of resources. Detection is, however, largely based on visual observation and the Police being in the right place at the right time.
Illegal stopping and parking	Currently requires visual observation and the Police being in the right place at the right time.

Road Rule Category	**Enforcement Problems**
Use of technology in vehicles	Could be difficult for Police to observe drivers using illegal technology while driving if these technologies are placed low down in the vehicle.
Careless/Reckless Driving	No particular enforcement difficulties identified. Detection is, however, largely based on visual observation and the Police being in the right place at the right time.
Licensing and Registration	Generally, no enforcement difficulties identified. Detection is, however, largely based on visual observation. Road Rule 211 – Vehicle power restrictions for probationary drivers – difficult to determine if a vehicle exceeds the power to weight ratio.
Heavy vehicles – Mass dimensions and driving hours	Difficult to establish if a vehicle is exceeding its mass and dimension limits as this requires weigh stations. Difficult to accurately establish if the driver has exceeded their maximum allowable driving hours. Difficult to determine if the speed limiter has been tampered with as this requires specialist equipment.
Bicyclists and Motorcyclists	No particular difficulties in detecting traffic violations. Motorcyclists are difficult to intercept due to their speed and manoeuvrability. Difficult to establish identity of bicyclists.
Trams and Buses	No difficulties identified.
Intercepting Vehicles	Motorcyclists are difficult to intercept due to their speed and manoeuvrability. Heavy vehicles are sometimes difficult to intercept on busy roads. Intercepting any vehicle from a standing start is difficult and requires Police to drive at high speeds.
Infringement Processing	Processing of infringement notices is time-consuming and is currently done manually.
Evidence of Offence	Often there is no evidence, apart from the Police officer’s word, that an offence occurred.

4 CURRENT USE OF TECHNOLOGY TO SUPPORT TRAFFIC ENFORCEMENT

4.1 Traffic law enforcement

Road traffic enforcement has been defined as activities concentrated on preventing and controlling illegal and dangerous road user behaviour in order to achieve safe and efficient road travel. Efficient and effective enforcement of road rules can play a crucial role in reducing road trauma. Indeed, the importance of road law enforcement in road trauma reduction has been demonstrated in a number of studies. A recent review by Elliot and Broughton (2004) concluded that the majority of the 66 studies reviewed found that increased levels of police enforcement reduced the incidence of road crashes. However, road traffic enforcement can be very expensive, requiring high levels of police resources. Traditionally, traffic enforcement has relied on the deployment of marked or unmarked police vehicles that either move through the traffic or are stationed at a specific site. While these methods have been shown to have a positive effect on road user behaviour, this effect is often only temporary and does not extend far beyond the enforcement site. High levels of police resources are also required to cover even a small proportion of the road network and, thus, these methods are extremely costly (Zaal, 1994).

It has been recognised that the use of automated enforcement technologies can improve the effectiveness, accuracy and efficiency of road enforcement activities by increasing the actual and perceived chance of traffic violations being detected without increasing the number of police resources required. Automated enforcement also has a number of other benefits over traditional enforcement measures including providing definitive evidence (e.g., photographic) that a violation has been committed and by simplifying the process of producing infringement notices (Harper, 1991; Zaal, 1994). The use of automated enforcement technologies is becoming increasingly popular worldwide and many technologies are currently used by police to enforce certain road rules. These devices include speed and red light cameras, alcohol ignition interlocks and heavy vehicle data loggers.

While police in Australia already use a number of technologies to support their enforcement activities, there now exists an increasingly wide range of ITS and telematics technologies which have significant potential to further enhance the effectiveness and efficiency of police enforcement activities. These technologies can be classed into two categories: those that are used to prevent drivers from engaging in illegal driving behaviours in the first place and those that support the enforcement of road rules that have already been broken by drivers.

This chapter briefly reviews existing technologies that are currently being used by police, either in Australia or overseas, to enforce road traffic laws. Also reviewed are ITS and telematics technologies that either currently exist or could be modified or brought together to further support police enforcement of safety-critical road laws.

4.2 Current automatic enforcement technologies

There is a wide range of technologies currently being used by police to support their road traffic enforcement activities. These technologies can be classed as those that are designed to prevent drivers from engaging in illegal driving behaviours in the first instance and those that support the enforcement of road rules and punishment of drivers once they have violated them. This section briefly reviews these current technologies and, where data are available, discusses their effectiveness in reducing traffic violations and road crashes.

4.2.1 Technologies Aimed at Preventing Traffic Violations

Enforcement technologies, like most traffic enforcement measures, aim to induce adherence to the road rules in two ways: by trying to deter or prevent road users from violating the road rules and detecting and punishing those users that have breached the road rules. There are, however, enforcement technologies that are designed specifically to prevent drivers from engaging in illegal driving behaviours. One of these technologies that is currently used by police is the alcohol ignition interlock.

Alcohol Ignition Interlocks

Alcohol ignition interlock systems have been introduced or are currently being trialled in a number of countries including a number of states in Australia in an effort to reduce repeat drink-driving offences. Despite reductions in drink-driving offences in recent years, alcohol still remains a large problem, with drink-drivers contributing to around 20 percent of Victoria's annual road toll. Recidivist drink-drivers are also an increasing problem with 35 percent of the drivers who were charged with drink-driving in Victoria in 2000 having one or more prior drink-drinking convictions (Victorian Government, 2002). In recognition of this growing repeat drink-driver problem, the Victorian Government has implemented an alcohol ignition interlock program, whereby those drivers charged with a drink-driving offence who have at least one prior drink-driving conviction in the last ten years are required to have an alcohol interlock fitted to their vehicle for a period of 6 months to 3 years.

An alcohol interlock is a breath-testing device that is wired into a vehicle's ignition. They require drivers to provide a breath sample by blowing into the breathalyser unit and obtain a Blood Alcohol Concentration (BAC) reading below a pre-determined limit before the vehicle will start. The interlock system also records information such as vehicle use and any attempts made to circumvent the device.

A number of evaluation studies overseas have found that recidivism rates reduce with the use of alcohol interlocks, but that these positive results are only present while the interlock is fitted (Coben & Larkin, 1999; Dussault & Gendreau, 2000; Fulkerson, 2003). In a 3-year US study on alcohol interlocks, Falkerson found that recidivist drink-drivers who had the interlock fitted to their car were half as likely to receive a subsequent drink-driving conviction in the following three years than repeat offenders who did not have an interlock equipped to their vehicle. Currently, there is no long-term data on the effectiveness of the Victorian alcohol interlock program (Schonfeld & Sheehan, 2004).

There are a number of issues with the use of alcohol interlocks that can influence their effectiveness as a deterrence device. The first issue relates to drivers simply using a vehicle other than the one in which the interlock has been fitted. Another issue relates to drivers circumventing the interlock device by getting another person to blow into the device, or placing a filter over the mouthpiece to prevent alcohol getting to the sensor. Manufacturers are, however, working towards developing alcohol interlocks that are less susceptible to circumvention by drivers. Governments have also put in place severe penalties (e.g., imprisonment) for drivers who attempt to violate the conditions of their interlock program either through circumvention of the interlock or by driving another vehicle (Victorian Government, 2002).

Recently, Saab has developed an alcohol breathalyser called the Alcokey. The Alcokey is a car key that doubles as a miniature breathalyser to prevent potential drink drivers from starting their vehicles. The Saab Alcokey has a small mouthpiece in the car's key fob, which is activated when the driver presses the 'doors open' button on the car key. The driver then blows into a small mouthpiece at the end of the key to provide a breath sample. This sample is analysed, and a small green or red light on the key is illuminated. If the green light is shown, the key will transmit an 'all clear’ signal to the car’s electronic control unit to allow the engine to be started. If a red light is shown, the ‘all clear’ signal will not be transmitted and the engine will remain immobilised. The Alcokey has been trialled in Sweden with the support of the Swedish Road Administration and Saab expects the device to be available as an optional extra in the Swedish market by 2007 (PACTS, 2005).

4.2.2 Technologies Aimed at Detecting Traffic Violations

A wide range of in-vehicle and external-to-vehicle technologies that are designed to detect traffic violations are currently used by police around the world. While it is recognised that use of these devices has the effect of deterring drivers from engaging in illegal driving behaviours, they do this by detecting traffic violations as they occur (e.g., speed and red light cameras) or post violation (e.g., data loggers or event recorders) rather than trying to prevent drivers from engaging in the illegal behaviour in the first place. These technologies are discussed below.

Speed Cameras

The use of automated speed enforcement technologies, namely fixed and mobile speed cameras, is widespread throughout most countries around the world. Speed cameras, particularly fixed cameras, allow police to detect a far greater number of speeding motorists over a wider section of the road network than is possible using traditional methods (e.g., on-site detection and punishment), without requiring an increase in police resources. In Victoria, speed camera trials commenced in 1985 and the use of 54 mobile speed cameras followed in 1991. Fixed speed cameras were installed on the Monash Freeway (CityLink) in 2000 and now operate at various points on the Monash and Melbourne-Geelong Freeways, the Western Ring Road and the CityLink Tunnels.

Mobile cameras are moved to various accident black spots to enforce speed limits, while fixed cameras are permanently located on selected roads and intersections. Speed cameras usually consist of detection equipment, a camera, video or digital image capturing device and a processing unit. In Victoria, mobile speed cameras consist of the Gatsometer MRC system, which measures the speed of vehicles travelling in either or both directions, and takes a photograph of any vehicles travelling faster than the speed limit. The camera and speed measurement device are mounted on a tripod or mounted in a vehicle parked on the side of the road (Department of Justice, 2004).

Fixed-position speed cameras measure the speed of passing vehicles using three strips of sensors, which are buried at regular intervals in the road surface. These sensors are connected by wires to a camera mounted above the roadway. As the wheels of a vehicle pass over the sensors the time is recorded. The speed measurement device measures the time it takes the vehicle to travel between the sensors and if the motorist is travelling too fast, the system alerts the camera to capture an image of the passing vehicle. The fixed speed cameras used in Victoria employ a range of video and digital technology to capture images of speeding vehicles. The information contained in the image (e.g., date time, vehicle speed and vehicle registration) is then used to identify the owner/driver of the vehicle and a speed infringement notice is issued (Department of Justice, 2004).

Numerous studies have evaluated the impact of fixed-position and mobile speed cameras on speeding behaviour. Pilkington and Kinra (2005) reviewed a number of speed camera evaluation studies from a range of countries and found that the existing research demonstrates that speed cameras are effective at reducing fatal and injury crashes. Specifically, they found that across studies, speed cameras have resulted in a 12 to 25 percent decrease in injuries and 17 to 71 percent reduction in fatalities in the immediate vicinity of the cameras. The authors, however, remarked that many of the evaluation studies reviewed suffered from methodological problems and that their results should be interpreted with caution. Data released by the Victorian Police shows that, in Victoria, the number of infringements issued by mobile speed cameras decreased from 254,319 for the period October to December 2002 down to 180,242 infringements for the same period in 2003 (Department of Justice, 2004). These figures suggest that use of speed cameras is having a positive effect on reducing motorists' speed. Indeed, data from the VicRoads speed surveys show that average speeds in 60 km/h zones have decreased from 63.4 km/h in November 2000 to 60.2 in November 2004 (VicRoads, 2004). Diamantopoulou and Corben (2002) evaluated the Victorian fixed speed cameras and found that the fixed-position speed cameras reduced the proportion of drivers exceeding the speed limit in the Domain CityLink tunnel by between 66 and 79 percent and reduced the average speed of vehicles from 75.05 km/h to 72.50 km/h.

Point-to-point speed cameras are currently being trialled in Victoria at four points along the Hume Freeway. These cameras have also been trialled in several countries and more recently in the Australian state of NSW. Point-to-point speed camera technology uses two or more cameras mounted at pre-set distances along a road. The cameras are able to measure both the average speed of a vehicle between two points and the spot speed at an individual camera site. The cameras determine the average speed of a vehicle by dividing the distance travelled by the time taken to travel between the two camera points (RTA, 2004).

The results of a trial of point-to-point speed cameras in the UK revealed that fatal and serious injuries fell by 31 percent, but that the results from the point-to-point camera site were not significantly different from the general effect (Gains, Humble, Heydecker & Robertson, 2003). Due to their recent introduction, no evaluation studies have yet examined the effectiveness of point-to-point speed cameras in Victoria.

A number of criticisms have been levelled at the use of speed cameras: that the cameras are there for revenue raising; that the speed threshold at which motorists are fined is too low; that the cameras are inaccurate; and that the cameras are deliberately hidden to catch out drivers. A more comprehensive list of speed camera criticisms and government responses can be found at: www.justice.vic.gov.au/roadsafety.

Red Light Cameras

Running red lights is a significant contributor to crashes at signalised intersections, accounting for 15 to 21 percent of all intersection crashes (Greene, 2000). As with speed cameras, the use of red light cameras allows police to accurately detect a far greater number of red light runners than is possible using traditional methods (e.g., on-site surveillance), without requiring an increase in police resources. Red light cameras were first installed at intersections in Victoria in 1983 and are now used widely across the Victorian road network (Hakkert & Gitelman, 2003).

Red light cameras are connected to the traffic signal control system and automatically photograph vehicles that travel across the intersection after the red light signal is displayed. The camera is most commonly triggered by a wire induction loop embedded in the crosswalk section of the intersection about 10 cm below the road surface. Other trigger mechanisms, including radar, laser, video loop and air-tube sensors, can also be used to trigger the camera. During the green and amber signal phases, the red light camera is deactivated and thus cannot take photographs. During the red signal phases, the camera is activated a short period of time (usually 0.3 secs) after the signal has turned red. If a vehicle drives over the embedded loops the camera takes two photographs; one as the vehicle enters the intersection and another after a short time delay. Taking two photographs ensures that the vehicle has actually travelled through the intersection. The photograph allows vehicle details (e.g., registration plate) to be identified and also contains other information such as date and time of the offence and the amount of time that had elapsed since the signal turned red. This information is then used to issue an infringement notice to the driver.

Research has shown that red light cameras are an effective red light running enforcement measure. In 2003, Retting, Ferguson and Hakkert reviewed a range of international studies on the effectiveness of red light cameras to reduce red light violations and crashes. The studies evaluated reported that the use of red light cameras reduced the incidence of red light violations by 40 to 50 percent. In terms of crash reductions, the studies reviewed suffer from similar methodological flaws to those of the speed camera evaluation studies, but have generally shown that the use of red light cameras significantly reduces crashes at signalised intersections, particularly right-angle crashes. However, this research also showed that the incidence of rear-end crashes increased at signalised intersections following the installation of the cameras, presumably as a result of motorists stopping quickly to avoid running a red light. A meta-analysis of red light camera evaluations by Hakkert and Gitelman (2003) also revealed similar results. They found that the use of red light cameras results in a 40 to 60 percent reduction in red light violations and an average reduction of 18 percent in injury crashes at intersections where the cameras are installed.

Combined Speed and Red Light Cameras

Speed and red-light cameras have been widely used in Victoria over the past decade. In September 2003, 65 new red light, speed cameras were implemented at various site across Victoria. Fifty-four of the cameras were permanently installed at 54 signalised intersections, while the other 11 cameras are rotated between 31 intersections. The intersections at which the cameras were installed were chosen due the high incidence of fatal and serious injury crashes that occur at these sites (ArriveAlive, 2005).

Combined red light, speed cameras operate simultaneously as both red light and speed cameras. During the green and amber phases of traffic signals the cameras operate as fixed speed cameras only. They are able to detect the speed of vehicles passing through the intersection and capture images of those vehicles that are exceeding the speed limit. During the red light phase, the cameras continue to operate as speed detection devices but, in addition, are able to detect images of vehicles entering the intersection after the red signal has been displayed. The cameras make it possible to detect two traffic infringements from the same event in the case of a vehicle entering the intersection against the signal at a speed above the posted speed limit. As the introduction of combined red light, speed cameras has only recently commenced in Victoria, no evaluation of the effectiveness of these devices in reducing traffic violations or crashes has been conducted.

In-vehicle Data Recorders

There are two types of in-vehicle data recorders that can be fitted to cars. The first are event data recorders (EDRs), sometimes known as accident data recorders or crash data recorders. These are similar to flight data recorders or ‘black boxes’ used in aviation, however EDRs do not record voices. EDRs record data prior to, and during a crash to assist accident investigators in reconstructing the events that occurred. EDRs can record vehicle speed or direction of travel, steering or brake performance, including whether brakes were applied before an accident, airbag deployment status and driver seat belt usage (NHTSA, 2001). EDRs have been used for some time in crash investigations, and are now fitted to many new vehicles. However, EDRs are designed to record vehicle information for a limited period of time surrounding an event, usually a crash.

While police and other law enforcement agencies have subpoenaed data from EDRs in the past, their application as a traffic law enforcement device is limited to those occasions where a vehicle has been involved in a collision of some kind because the system will only save data immediately prior to and during a crash. There are also many privacy issues surrounding the use of data collected by EDRs and the state of Connecticut in the US has even passed legislation preventing the data from being extracted and used for enforcement purposes without prior written consent from the vehicle owner or a search warrant (Connecticut General Assembly, 2005).

The second type of data recorder, and one that has been used more widely for enforcement purposes, is on-board computers or journey data recorders (JDRs). These devices are widely used in the commercial and heavy vehicle transport industry as fleet management aids. JDRs are capable of collecting many hours of real-time driving data, including information regarding journey start and end times, distance travelled, maximum and average speed, engine RPM, acceleration and braking parameters (Al Marzooqi, 2003). In terms of safety-related enforcement, JDRs are capable of providing data on speed violations, driving hours violations for heavy vehicle drivers, and violating company safety regulations (Dole, 1999).

Unlike EDRs, JDRs record a range of driving parameters continuously and, as such, they can be used for enforcement purposes to monitor drivers compliance with road rules. In Malaysia, continuous speed monitoring/recorders devices have been compulsory on excursion buses, express buses and any type of government vehicle since September 2001 (Mahdar, 2003). In the US, continuous driving data loggers are also being promoted for private vehicle use, particularly to parents as a means of monitoring their children's driving (Cockburn, 2005), and insurance companies are encouraging drivers to join voluntary driver monitoring programs in exchange for a reduction in their insurance premiums (David, 2004).

Fleet studies have shown that the fitment of vehicle data recorders can reduce crashes by 20 to 30 percent (NHTSA, 2001; Wouters & Bos, 2000). To the knowledge of the authors, however, no studies have examined the effect of data recorders on driving violations and whether these are an effective traffic enforcement device.

Automatic Licence Plate Recognition Systems

Automatic licence plate recognition (ALPR) systems are one form of automatic vehicle identification (AVI) systems, which automatically detect and read the registration/licence plates of vehicles that pass the system's cameras. ALPR systems can either be fixed-position units or mobile units and include a digital or video camera or closed circuit television (CCTV), image processing software, a control computer and illumination equipment such as infra-red to light up the registration plate (Hoffman, 2003). ALPR systems have been used in a number of different applications, including access control to secured or restricted areas such as car parks or toll ways, traffic control, and enforcement to identify vehicles involved in red light and speed violations, obtain information on the average speed of a vehicle between two points and to track stolen vehicles (Garibotto et al., 2003; Hoffman, 2003). In some applications, such as electronic tolling and speed and red-light enforcement, ALPR systems capture an image of the registration plate number so the vehicle owner can be automatically identified and issued with the toll or fine, or their registration number can be displayed on a variable message sign further down the road. These systems replace the manual process of a human having to verify registration details and produce an infringement notice, thereby reducing administration costs and processing times (Hoffman, 2003). In other applications, such as secure-access control, the vehicle's registration plate number is checked against a database of acceptable numbers to determine whether a truck can bypass a weigh station or a vehicle can enter a restricted car park. ALPR systems are also currently equipped to Police vehicles in the UK to automatically read vehicle registration plates and check them against details in a database to determine if the vehicle is stolen, unregistered or if the owner has outstanding infringements. If so, the Police are able to intercept the vehicle, without having to manually enter the vehicle's details (PACTS, 2005).

To the knowledge of the authors, no evaluation studies have examined whether and how the use of ALPR systems affect driver behaviour in terms of reductions in violations or crashes. Many of the studies have focused on the accuracy of the systems in being able to detect and read registration plates. The early ALPR systems suffered from low recognition rates due to factors such as sun glare, poor quality registration plates and the wide variety of registration plates used (e.g., different fonts, sizes and colours). The new ALPR systems, however, have very high accuracy rates due to improvements in software and hardware, which can compensate for small errors and differences in the fonts and colours used on licence plates (Hoffman, 2003). Garibotto and colleagues (2003) compared the percentage of registration plates that were recognised by a mobile ALPR system to the number of plates that were deemed readable by a human observer. They reported that the recognition performance of a mobile ALPR system was above 90 percent under a range of driving, lighting and environmental conditions; that is, above 90 percent of the licence plates that were deemed readable by an observer were accurately recognised by the ALPR system. Other research has confirmed these figures, reporting that current ALPR systems are capable of accurately reading 95 percent of registration plates (PACTS, 2005).

4.3 Summary

The use of automated enforcement technologies is becoming increasingly popular both in Australia and overseas, with a range of technologies currently used by police to enforce certain road rules. These technologies include speed and red light cameras, alcohol ignition interlocks, heavy vehicle data loggers and automatic licence plate recognition systems. The use of automated enforcement technologies can improve the effectiveness, accuracy and efficiency of police traffic enforcement activities by increasing the actual and perceived chance of traffic violations being detected without increasing the number of police resources required. Automated enforcement also has a number of other benefits over traditional enforcement measures including providing evidence (e.g., photographic) that a violation has been committed and by simplifying the process of producing infringement notices.

5 ITS TECHNOLOGIES TO ENHANCE TRAFFIC LAW ENFORCEMENT

5.1 Introduction

There is a wide range of ITS technologies that either exist or are under development that could be used by Police to further support and enhance their enforcement of safety-critical road rules. These technologies could be used either in their current form or could be modified or brought together to enhance Police enforcement of those road rules that they already enforce and to support enforcement activities that they currently have difficulty with.

Stage 3 of the project aimed to identify new and existing ITS and telematics technologies that could be used to optimise Police enforcement of traffic laws, with a particular emphasis on identifying technologies to assist the enforcement of those road rules that Police currently have difficulty enforcing. These ITS and telematics technologies were identified through a review of relevant ITS literature and ITS websites, and also an ITS workshop held at MUARC, involving a group of ITS and telematics experts from a range of areas, including research, policy development and industry (e.g., telematics suppliers).

A number of new and existing ITS and telematics technologies that can be used to support Police traffic enforcement were identified during Stage 3. The technologies identified included in-vehicle, infrastructure-based and cooperative systems; systems that would both prevent drivers from engaging in illegal driving behaviours and support the enforcement of those road rules that have been violated. The technologies identified are discussed in relation to the safety-critical road rule/enforcement categories identified in Stages 1 and 2 of the project. One road rule category, relating to trams and buses, was not examined in the workshop, as the Police reported in the focus group that they rarely have to enforce the road rules relating specifically to these road users. In addition, several other rule categories were collapsed into one category – violation detection problems – because they all were concerned with the same enforcement problem. Therefore, only 13 road rule and enforcement categories were examined in the workshop.

Table 5.1 details the 13 enforcement categories discussed and lists the associated ITS and telematics technologies identified through the literature review and ITS expert workshop. The ITS and telematics technologies are discussed in more detail in the following sections. Before discussing the identified technologies, it should be noted that this list of potential ITS and telematics technologies is a first ‘cut’ of possible technologies that could be used for traffic enforcement purposes and, thus, is not exhaustive. Also, many of the issues surrounding the feasibility of using some of the identified technologies for enforcement purposes have not been examined. It is expected that this would be the focus of future research into the use of ITS for traffic enforcement purposes.

Table 2 List of ITS and Telematics technologies that could support and enhance Police traffic enforcement

Enforcement Category	Existing Technologies	New Technologies
Speeding	Intelligent Speed Adaptation (alerting and limiting) Flashing variable speed signs installed in all school zones to indicate temporarily reduced speed limit In-vehicle dynamic displays that present speed limit information inside the vehicle School zone information built into existing route guidance or other system – an alert is issued to drivers by the system when they approach a school zone (eg Road Angel product)	Dedicated short range communication (DSRC) system transmitting brief message to car radio that they are approaching a school zone
Driving Under the Influence of Alcohol and Other Drugs	Alcohol Ignition Interlock Alcohol 'sniffer' system, which passively detects alcohol on the driver's breath in car cockpit – warns the driver to take a breath test, and either does nothing, warns the driver, immobilises the vehicle or limits vehicle speed	Telematics systems that immobilise the vehicle during high alcohol times (e.g., at night) Use of closed circuit TV (CCTV) to detect potentially impaired drivers approaching breath/salvia testing site to better target alcohol/drug testing
Seatbelt Wearing	Seatbelt reminder or interlock systems for all seating positions Speed cameras that take front image of vehicle and are also capable of detecting unrestrained driver/front seat occupant	System that detects unrestrained occupants and issues a warning signal on the exterior of the vehicle that can then be easily detected by Police
Giving Way (emergency vehicles)	In-vehicle emergency vehicle warning device that issue warnings when emergency vehicle approaching – could provide directional information regarding location of emergency vehicle	Transmitters on emergency vehicles that transmit approach warning to vehicles via the car radio or some other system (eg route navigation)
Keeping a safe following distance	Following Distance Warning/Headway Feedback systems Adaptive Cruise Control Laser-based following distance detection device integrated into hand-held speed detector or mounted on stationary Police vehicle	Roadside following distance detection system that provides visual headway feedback to drivers via a roadside variable message sign (could be linked with current speed feedback systems)
Use of technology in vehicles	Mobile phone blockers or jammers were raised as possible solutions, however these are currently illegal in Australia	Mobile phone detector that alerts Police to a mobile phone being used in a vehicle so that they can investigate further
Licensing and Registration	Automatic Licence Plate readers Electronic licence/key – do not allow disqualified/unlicensed drivers to start vehicle	Engine readers currently used on heavy vehicles could be used to detect if power ratio has been exceeded Speed/acceleration limiting devices on probationary licence holders' vehicles

Table 2 (continued)

Enforcement Category	Existing Technologies	New Technologies
Heavy vehicles – Mass dimensions and driving hours	"Safety-Cam" system to detect violation of driving hours Electronic log books or electronic licences to record driving hours Weigh-in-motion stations and length measuring devices to detect violations of mass and dimension limits Intelligent Speed Adaptation (limiting)	Speed limiter tamper detection device that could be used by police to detect if the speed limiter is operating correctly.
Bicyclists and Motorcyclists	Intelligent Speed Adaptation (limiting) for motorcycles	
Detection of violations	Electronic Vehicle Identification Closed Circuit Television In-vehicle Event Data Recorders	
Intercepting Vehicles	Remote vehicle engine immobiliser Star Chase – adhesive vehicle tracking dart fired by Police from a hand-held device onto an offending vehicle	Remote vehicle speed governing device
Infringement Processing	Automatic Licence Plate Recognition Automated infringement processing software – to reduce manual processing	
Evidence of Offence	Forward facing in-vehicle video recorders equipped to Police vehicles In-vehicle Event Data Recorder – obtain driving data from offending vehicles	

Note: 'Existing Technologies' refer to technologies that already exist as commercial systems or advanced prototypes. 'New Technologies' refer to those ideas for systems/devices that were formulated during the workshop or that do not currently exist in advanced prototype form.

5.2 ITS Technologies to Enhance and Support the Enforcement of Victorian Road Rules and Regulations

5.2.1 Speeding

A number of in-vehicle and infrastructure-based ITS and telematics technologies were identified that could assist Police in the enforcement of speed-related road rules. These include Intelligent Speed Adaptation (alerting and limiting), in-vehicle dynamic displays, flashing variable speed signs, school zone information built into existing route guidance or other systems, and brief school zone approach messages/alerts transmitted via a DSRC system. These technologies are discussed below.

Intelligent Speed Adaptation

A class of in-vehicle ITS aimed at encouraging or preventing drivers from exceeding the speed limit is Intelligent Speed Adaptation (ISA). ISA is a generic term for systems that automatically warn the driver and/or limit vehicle speed when the driver, intentionally or inadvertently, exceeds the posted speed limit by a predetermined amount. ISA systems establish the position of the vehicle via GPS or roadside beacons, compare the current speed and position of the vehicle with the local posted speed limit and issue warnings or limit vehicle speed if the vehicle exceeds this posted limit. There are two main variants of ISA: speed *alerting* and speed *limiting* systems.

Speed alerting systems warn the driver if he/she is exceeding the posted speed limit in a given location. There are two variants of speed alerting systems: informative and actively supporting. Informative ISA provide the driver with an auditory warning or a combination of auditory and visual warnings (e.g., a picture of a road sign showing the posted limit) if they exceed the posted speed limit beyond a specified threshold (e.g., 3 km/hr above the posted limit) (van Boxtel, 1999). Actively supporting ISA provides the driver with a tactile warning in the form of increased upward pressure or a vibration felt through the accelerator pedal. The driver is usually able to override the resistance in the accelerator pedal if required via a ‘kick-down’ function (van Boxtel, 1999).

Speed *limiting* devices prevent drivers from exceeding the posted, or some, other, speed limit. With variable speed limiters, the maximum speed of the vehicle is automatically limited to a pre-determined speed at particular locations, usually the posted speed limit. Vehicle speed is limited by one of two control mechanisms; speed governors or speed retarders. Speed governors interrupt the fuel supply to the engine once the vehicle has reached the maximum allowable speed, thereby restricting the speed of the vehicle (Comte & Lansdown, 1997). Speed retarders regulate vehicle speed by creating a braking force in the opposite direction to the rotation of the drive system, and are typically installed on vehicle transmission braking systems (Comte & Lansdown, 1997).

ISA systems can also be fixed, dynamic or variable. Fixed ISA systems use permanent speed limits to issue speed warnings to drivers and are not capable of detecting temporary changes in speed limits. Dynamic and variable ISA systems are, however, designed to reduce the speed of drivers in the event of adverse conditions or temporary changes in speed limits. These forms of ISA can be either alerting or limiting. Dynamic (sometimes called weather-related) ISA systems provide information about temporarily lowered speed limits which have been implemented because of road works, accidents or dangerous weather or road conditions such as fog, heavy rain or snowfall (Carsten & Tate, 2000; Peltola & Kulmala, 2000). Variable ISA systems inform drivers of locations in the road network where a lower speed is regularly implemented; such as in school zones during drop-off and pick up times. Variable systems are thus responsive to local changes in speed limits that are implemented at pre-set times or locations, while dynamic systems react to unpredictable, temporary adjustments in speed limits due to road works and changing weather conditions (Carsten & Tate, 2000). Information regarding temporary or transient adjustments in speed limits is inputted into a central database containing all speed limits for a particular region and are transmitted to vehicles in this region in real-time via road side beacons or via GPS or an on-board internet connection. Speed limits that are adjusted regularly at various times of day (e.g., school zones) can also be built into the on-board digital speed limit map (Regan, Young & Haworth, 2003).

A large body of research has examined the potential safety benefits of ISA and its influence, both positive and negative, on driving performance. Speed alerting systems have a number of positive safety benefits, including a reduction of up to 5 km/h in mean speeds, as well as a reduction in speed variance and speed violations (Hjälmdahl et al., 2002; Lahrmann et al., 2001; Regan et al., 2005; Sundberg, 2001; Várhelyi, et al., 2002). Feedback obtained from test drivers in a number of trials has also revealed that driving a vehicle equipped with a speed alerting system, particularly the actively supporting variant, leads to an increased awareness of current speed limits and makes it easier to adhere to these speed limits, particularly on low-speed roads (e.g., 30 km/h) (Sundberg, 2001; Vägverket, 2003). Despite these lower average speeds, there is little evidence that drivers engage in compensatory behaviours when using ISA such as running red lights and inappropriate speeds at intersections and around bends. Driver acceptance of actively supporting and informative ISA systems is generally quite high, with drivers typically reporting favourable attitudes towards the system. However, there is evidence that the informative and actively supporting ISA systems can lead to a decrease in driving pleasure, increased frustration at lower speeds and increases in travel times, while actively supporting systems can also increase the pressure imposed by other motorists to drive faster (Biding & Lind, 2002; Regan et al., 2005; Sundberg, 2001; Vägverket, 2003).

Substantial road safety benefits have also been demonstrated for speed limiting systems, including decreases in average speeds, more homogenous speed patterns and an improvement in interactions with other road users (Almqvist & Nygård, 1997; Duynstee et al., 2001; Várhelyi et al., 1998). Research conducted in Australia, Sweden and the United Kingdom, estimates that the use of ISA *alerting* systems is expected to reduce the number of fatal crashes by between 7 and 32 percent depending on road type (Hjämldahl, 2004; Regan et al., 2006) and that ISA *limiting* systems are expected to reduce fatal crashes by up to 48 percent (Carsten & Fowkes, 2000). In addition to these safety benefits, speed limiting systems are also expected to reduce air pollution and fuel consumption (Almqvist & Nygård, 1997). One negative behaviour that has been observed with use of the speed limiting system is the tendency for drivers to adopt shorter time-headways when following a slow lead car (Várhelyi et al., 1998), although in some studies it was observed that drivers tended to keep a greater distance from other road users when driving a speed limited vehicle (Almqvist & Nygård, 1997; Duynstee et al., 2001). Also, while variable speed limiting systems are the most effective means of speed reduction when compared to variable speed alerting systems, speed limiting systems are deemed as the least acceptable by drivers than alerting systems.

Based on the research reviewed, the use of ISA alerting and limiting systems has great potential to assist police in enforcing compliance with the current speed limit and improve road safety by encouraging drivers not to exceed the speed limit. Functional ISA systems are already in operation in several countries and will continue to develop further through the conduct of on-going field and simulator trials. There are a number of issues that need to be resolved, however, before ISA can be deployed on a wide-scale. The first of these issues relates to the infrastructure required for ISA systems to operate, such as the installation of roadside transmitters/beacons and/or the development of digital road network maps containing speed limits that cover the entire road network. Another issue that will need to be resolved is how the digital maps on GPS-based ISA systems can be easily and quickly updated with new speed limit information, particularly for dynamic ISA systems where new speed limit information would need to be available in real time. Community acceptance and demand for ISA is another issue. While acceptance of ISA systems appears to be high among test drivers (Regan et al., 2005), there may be resistance to the introduction of this technology by some in the wider driving community. One use of ISA that is likely to gain acceptance is the compulsory fitment of limiting versions of these systems to the vehicles of recidivist and serious speed offenders. However, the benefits and costs of fitting ISA systems to the wider vehicle fleet in the future should also be considered.

In-vehicle Information Displays

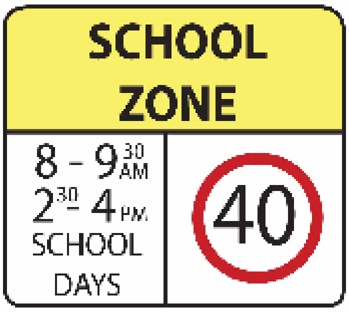
In-vehicle information displays can be used in the future to present drivers with information that would normally appear on static or variable signs outside of the vehicle (Regan, 2004). In relation to speed, dynamic in-vehicle displays could be used to provide drivers with information regarding temporary changes in speed limits due to roadworks, road or weather conditions or an accident. This information could be transmitted to vehicles in the area via beacons placed on the side of the road or via the Internet. The visual display used could be a stand-alone display or it is possible that it could be integrated as part of a multi-functional display into existing in-vehicle displays such as the route navigation display. Although there has been no research examining this issue directly, it is possible that drivers may be more likely to detect and adhere to regulatory information displayed inside the vehicle (particularly if the visual information is accompanied by an auditory chime/message) than information presented on external static or variable message signs given that they do not have to search out this information in the road environment.

It is important to note that in-vehicle information displays of this kind could be used to display a wide range of information, not just speed information, to drivers that could help enforce road rules. For instance, it could alert drivers, using either visual or auditory alerts, to approaching traffic control devices such as stop, give way and no entry signs, and even inform them if they are travelling in a restricted use lane such as an emergency vehicle lane.

Flashing Variable Speed Signs

Flashing variable speed limit signs are installed at a number of school zones in Victoria to display the temporarily reduced speed limit during school crossing hours - 8.00am to 9.30am and 2.30pm to 4.00pm on school days. The members of the Stage 3 ITS workshop suggested that these variable speed limit signs should be installed at all school zones to alert drivers of the reduced speed limit during these times. Their argument for this was that these signs would remove the need for drivers to have to check the time to determine the current speed limit, as is the case with the current static school zone speed limit signs depicted in Figure 1.

Figure 1: Static school zone speed limit sign (Source: VicRoads)



In-Vehicle School Zone Information Alerts

The members of the workshop also noted that systems could be developed that provide drivers with in-vehicle alerts regarding the reduced speed limit when approaching school zones. In the first system they identified, school zone speed limit information would be built into existing satellite navigation systems. The system would use vehicle location and time of day information to issue auditory or visual alerts to drivers, warning of the reduced speed limit as they approach school zones. Such a system, known as the Road Angel, already exists as an aftermarket product in Australia. The second system identified by workshop members would use Dedicated Short Range Communication (DSRC) transmission equipment to transmit a brief auditory message or alert drivers over the car radio that they are approaching a school zone with a reduced limit. This radio alert would override other radio transmissions that are being broadcast at the time.

5.2.2 Driving Under the Influence of Alcohol and Other Drugs

Technology has been used for many years to enforce drink-driving offences. Breath and salvia testing technologies have been used for a number of years to test for impairment due to alcohol and other drugs (PACTS, 2005). More recently, alcohol ignition interlock or “Alcokey” systems have been introduced or are currently being trialled in a number of countries, including Australia, in an effort to reduce repeat drink-driving offences (refer to Chapter 4 for a discussion of alcohol interlock devices).

The review of the literature and workshop identified a number of other ITS technologies that could be used to enforce drink and drug driving laws. These include alcohol sniffer systems, performance tests, electronic licences and keys, Closed Circuit Television (CCTV) to target drug and alcohol testing, and telelmatics systems that immobilise the vehicles of recidivist offenders during high alcohol and drug use times.

Alcohol Sniffer Systems

Alcohol ‘sniffer’ systems remotely detect, using sensors, the presence of alcohol on the driver’s breath and, if alcohol is detected, then require drivers to blow into a breathalyser unit. If the breathalyser unit confirms the presence of alcohol, then the system either immobilises the vehicle or limits the speed of the vehicle to reduce crash risk and severity. These systems currently exist as prototype systems.

Performance Tests

Technologies that are capable of detecting and assessing impairment based on reaction times and coordination are under development. Such performance tests require the driver to complete and pass a psychomotor driving task (i.e., tracking or reaction time task) when they first enter the vehicle and, depending on the results, will either allow the ignition to be started or will immobilise the vehicle. These tests are capable of detecting impairment due to alcohol, illicit drugs and fatigue (PACTS, 2005; Zaal, 1994). One concern with these tests is that they may not, in all cases, detect impairment, particularly if the driver is just over the legal alcohol limit. Similarly, it is not clear what the effects of age or use of certain prescription medications would be on the performance of these tests. It is possible that these tests would prohibit some older drivers from driving simply because they have slower reaction times due to age.

Electronic Licences

Electronic licences and smartcard licence readers could be used to help enforce alcohol restrictions and alcohol interlock requirements. Electronic licences store information about the driver, such as their age, licence status and any restrictions or conditions on their licence, and use this information to determine if the person is allowed to drive. They could be used in conjunction with alcohol interlocks, for example, to disable the vehicle if the driver has a BAC in excess of the amount allowed by their licence type. Electronic licences could also be used to prevent drivers who are required to drive a vehicle fitted with an alcohol interlock from driving vehicles without these devices fitted.

CCTV to Better Target Alcohol and Drug Testing

CCTV or some form of video observation system could be used to detect potentially impaired drivers approaching breath/salvia testing sites in order to better target alcohol/drug testing by identifying and targeting those drivers who appear, based on their observed driving performance, to be impaired. Police monitoring the traffic using this technology could then radio to Police testers the details of vehicles they should target.

It is important to note that it is envisaged that such a system would be used to identify those motorists that are displaying certain unsafe driving behaviours to ensure that they are tested and not waved through the breath/drug testing site, rather than being used to target the testing of only certain motorists. In other words, every motorist would still have a chance of being tested, but those motorists who are likely to be under the influence of alcohol or drugs based on their driving behaviour are more likely to be identified and tested. This is important, as only targeting testing at certain driver groups based on their driving behaviour may reduce the general deterrence effect of random breath and drug testing initiatives.

Vehicle Immobilisation Technology

The workshop members noted that a telematics system could be developed and installed on vehicles to immobilise them during high alcohol and drug use times (e.g., at night or on the weekends). This system would prevent recidivist drink or drug drivers from driving their vehicle during these higher risk times.

Evidentiary Drug Testing Technology

A number of difficulties with the procedures involved in processing current drug tests were identified by the Police during the focus group and were discussed further by members of the workshop. It was noted that the issue of drug testing and drug impaired driving is a difficult one. Although preliminary drug testing is now carried out using saliva tests, obtaining evidentiary evidence of the existence of illicit drugs in a driver’s system is currently conducted through field impairment testing and medical assessment, not through the use of technology. In order to overcome the time-consuming process of conducting a range of preliminary saliva, impairment and medical tests in order to charge a driver with drug driving offences, it would require the development of all-in-one drug testing technologies that are capable of detecting the presence and level of drugs in the driver’s system with a high enough level of accuracy that their results can be used for evidentiary purposes. Such technology would eliminate the need for multiple tests to be carried out.

5.2.3 Seatbelt Wearing

A number of new technologies exist that could be used to enforce/encourage seatbelt wearing. A class of in-vehicle ITS that has been designed for this purpose is the seatbelt reminder and interlock systems.

Seatbelt Reminder and Seatbelt Interlock Systems

In an attempt to increase seatbelt wearing rates, several vehicle manufacturers have or are currently developing a range of seatbelt reminder systems. However, many of these seatbelt warning systems are linked to the driver’s seat only. The new seatbelt reminder and interlock systems are designed to detect unrestrained occupants in all seating positions

Seatbelt interlock systems are connected to one or more seats that contain sensors both within the seats and in the belt assembly. These sensors determine whether any occupant in the vehicle is unrestrained and, if so, the vehicle ignition is disabled. Although interlock systems were found to improve seat belt wearing rates, there was a negative public reaction to these systems, because consumers felt that they restricted their personal freedom and that they were unsophisticated and difficult to use (Regan, Oxley et al., 2001). As a result, vehicle manufacturers have since focused on developing the less aggressive seat belt *reminder* systems. Seatbelt reminder systems contain sensors in the seats and in the belt assembly to determine if any occupant in the vehicle is not wearing a seatbelt. If any occupant is detected in a seat and is not wearing a seat belt while the vehicle is travelling above a certain minimum speed, visual and auditory warnings are issued and these warnings typically increase in intensity the faster the vehicle travels.

A number of Australian and overseas studies have examined the effectiveness of seatbelt reminder systems in improving seat belt wearing rates and the acceptability of these systems to drivers. Long-term adaptation to a seatbelt reminder system was recently examined as part of the TAC SafeCar project. This system detected the presence of occupants in all five seating positions and issued visual and auditory warnings if one or more occupants were unrestrained. The results revealed that driver interaction with the seatbelt reminder system led to large decreases in the percentage of trips driven where an occupant was unbelted for any part of the trip, in the percentage of total driving time spent unbelted, in the time taken to fasten a seatbelt in response to system warnings and in the time spent unbuckled while travelling at speeds of 40 km/h and above. Driver acceptance of the system was also high, with drivers reporting that they found the seatbelt reminder system useful, effective and socially acceptable (Regan, et al, 2005).

Frontal Image Speed Cameras

Digital speed cameras have been developed that are able to take a frontal image of vehicles detected speeding. These cameras are capable of identifying the driver of the vehicle and the front licence plate. The image is detailed enough to determine if the two front occupants of the vehicle are wearing seatbelts (Jager et al., 2005). Currently, this system would only detect unrestrained drivers and front seat passengers in those vehicles that are detected exceeding the speed limit. However, systems are under development in Europe that are capable of automatically detecting seatbelt use using cameras and image processing technology. As the vehicle approaches the camera, an image is taken of the front of the vehicle and image processing technology determines if the occupants (at least front occupants) are restrained. If it detects that one or more of the occupants are unrestrained then Police can either stop the vehicle further down the road or the image of the vehicle and its licence plate can be transmitted to an infringement processing centre (PACTS, 2005).

External Seatbelt Alert System

During the workshop the members identified a system that could be developed to alert Police that the occupant(s) of a particular vehicle is unrestrained. This system would detect unrestrained occupants in the vehicle using sensors located in the seats and buckle assembly and would issue a warning signal on the exterior of the vehicle that can be easily detected by the Police. This external warning could be used in addition to an internal warning designed to alert the driver that an occupant is unrestrained and encourage them to buckle up. The most appropriate form of external warning would probably be a flashing visual warning located in a conspicuous position on the vehicle and that could not be mistaken by other drivers for turn indicators or any form of warning signal (e.g., the front or rear windscreen).

5.2.4 Giving Way (emergency vehicles)

Police members in the focus groups reported that they often experience difficulty with motorists not clearing a path or giving way to emergency vehicles. Technologies now exist that can provide drivers with an advanced warning of an approaching emergency vehicle in emergency mode (e.g., lights and sirens active) so they have more opportunity to move out of the emergency vehicle’s path.

Emergency Vehicle In-Vehicle Warning System

In-vehicle emergency vehicle proximity warning devices have been developed that issue warnings to drivers when an emergency vehicle is approaching. These systems are designed to alert drivers to the presence of an approaching emergency vehicle before they are likely to be able to hear the siren in order to provide drivers with more opportunity to clear a path for the emergency vehicle and, thus, avoid collisions. The effectiveness of an in-vehicle Advanced Warning Device (AWD) on the safety of driver interactions with emergency vehicles was evaluated in the advanced driving simulator located at MUARC (Lenné et al, 2004). The AWD provided in-vehicle audio and visual warnings to drivers when an emergency vehicle was within a 300 to 400 metre radius. The results revealed some positive safety benefits associated with the emergency vehicle AWD. In particular, the advanced warning provided by the AWD resulted in a reduction in mean speed when approaching intersections compared to when no emergency vehicle approach warnings were provided. Participants also changed lanes sooner and more quickly with AWD activated than without it and there was a greater relative separation between the emergency vehicle and the participants' vehicle when receiving the AWD warnings at the point at which the participants' vehicle changed lanes to clear a path for the emergency vehicle.

In future, such advanced warning devices could also provide directional information regarding what direction the emergency vehicle is approaching from. Such information may assist drivers to choose a more appropriate lane to move to in order to allow a clearer path for the emergency vehicle to move through.

An alternative system could provide drivers with a warning of an approaching emergency vehicle via the car radio or route navigation system rather than through a separate warning device.

Railway Level Crossing Warnings and Camera

It is estimated that there are approximately 100 crashes involving road vehicles and trains in Australia each year (Australian Transport Council, 2005). From 1997 to 2002, there were 74 deaths due to collisions between trains and motor vehicles at level crossings across Australia (Australian Transport Safety Bureau, 2003). In an attempt to reduce the number of collisions occurring at railway level crossings, a range of prototype technologies have been developed and evaluated that detect approaching trains and provide in-vehicle or infrastructure-based warnings to drivers at unsignalised railway level crossings that a train is approaching. These systems use a range of sensors and transmitters to detect approaching trains, such as sensors to detect the vibrations of approaching trains or transmitters located on trains that are detected by receivers in vehicles approaching the crossing (Carroll et al., 2002; Smailes, Carroll & Anderson, 2002). The approaching train warnings can be provided to drivers as visual and/or auditory warnings located within the vehicle or in the road environment around the crossing. The technical operation of these prototype train detection and warnings system has been evaluated and promising performance was observed. However, the accuracy of the sensors used is affected by placement, location and atmospheric conditions (Carroll et al., 2002; Smailes, Carroll & Anderson, 2002).

An alternative technology that could be used to deter drivers from driving through railway level crossings when the stop signals have been activated is the installation of detection cameras similar to red light cameras. These cameras could be linked to the railway crossing signals and take images of those vehicles that cross the crossing after the signals have been activated. Given the large number of signalised level crossings in Victoria and Australia it would an expensive exercise to install these cameras at even a small proportion of these crossings. The costs and benefits of installing such technology at level crossings would need to be examined and perhaps those level crossings with a known crash problem could be targeted initially.

5.2.5 Keeping a Safe Following Distance

Following Distance Warning/Headway Feedback systems

Rear-end collisions constitute a major proportion of all police-reported road crashes, particularly in urban areas. The majority of rear-end crashes are believed to be the result of one or both of two principal factors: driver inattention or distraction and following a lead vehicle too closely (Knipling, Wang & Yin, 1993). Rear collision warning devices are designed to monitor the time headway between vehicles and either alert the driver about an impending collision (Forward Collision Warning) or assist the driver to maintain an appropriate time headway from the lead vehicle by issuing visual and/or auditory alerts when drivers reach an unsafe following distance (Following Distance Warning). Time headway is defined as the distance in meters from a vehicle ahead divided by speed in meters per second.

A number of short-term on-road and simulation studies have examined the potential safety benefits of various headway detection and warning devices and their influence, both positive and negative, on following behaviour (Ben-Yaacov, Maltz & Shinar, 2002; Dingus et al., 1997; Fairclough, May & Carter, 1997; Maltz & Shinar, 2004; Regan et al., 2005; Shinar & Schechtman, 2002). This research has found that following distance detection and warning devices appear to improve following behaviour by decreasing the amount of time that drivers spend driving at short time headways. Moreover, the findings suggest that the reliability of the following distance warning systems (i.e., the number of false or nuisance warnings issued by the system) does not negatively influence headway maintenance. This means that systems do not have to be 100 percent accurate in order to have a positive effect on following behaviour.

Following Distance Detection Devices

A number of “close following detection devices” have been, or are currently being developed that can be used to detect drivers who are tailgating. Such systems provide Police with an objective measurement of vehicle’s following distance. Cameras are being developed in the UK, for example, that are capable of detecting the distance between vehicles and taking a visual image of those vehicles that are detected travelling too close to the vehicle in front. Similar following distance cameras have been used in the Netherlands and Israel for a number of years (PACTS, 2005).

An Australian company, Laser Technology, has also developed a hand-held laser speed detection system with a built-in following distance detection device. This “Distance Between Cars” device is capable of determining the distance between two moving vehicles. The device can be used in hand-held mode or mounted on a stationary Police vehicle. A camera unit can also be attached to the device so that an image of vehicles deemed to be following too closely can be taken (www.lasertechnology.com.au). The Victorian Police recently trialled the Distance Between Cars device during a recent tailgating enforcement campaign (Phil Lack, *personal communication*).

Following Distance Feedback System

During the workshop, members reported that a roadside following distance detection system that provides visual following distance feedback to drivers via a roadside advisory sign could be developed to make drivers aware of their following distance and encourage them to adopt longer following headways. This system could work in a similar manner to the current speed advisory sign systems used in Victoria (see Figure 2) that measure individual vehicle speed using laser or radar speed detection devices and display the vehicle’s speed on a variable message sign further down the road. Following distance feedback systems could be stand-alone systems, or linked with a speed feedback system to provide drivers with information regarding both their speed and following distance.

Figure 2 Speed feedback sign

5.2.6 Use of technology in vehicles

The use of mobile phone jammers fitted to vehicles has been identified as a possible solution to prevent drivers from using hand-held mobile phones while driving. Mobile phone jammers prevent mobile phone use by transmitting a signal on the same frequency as the mobile phone signal and at a high enough level so that the two signals cancel each other out. However, the use of these devices for this purpose is currently illegal in Australia and there are also a number of other problems associated with their use, including disruption of other radio transmissions and signals from other devices. Passive mobile phone blockers are not illegal in Australia and could also be used to prevent mobile phone use in vehicles. Passive mobile phone blockers use materials such as wall or roof linings embedded with metal fragments to prevent the mobile phone signal from reaching the phone. Thus, the roof lining of vehicles could, for example, be embedded with metal fragments to prevent the signal reaching phones located inside the vehicle. The major issue with this solution is that it would also prevent passengers from using their mobile phone and may have safety implications if drivers cannot use their phone to call for assistance in the event of an emergency, for example if they are trapped in the car.

One system that could be developed to help Police detect illegal mobile phone and in-vehicle visual display unit use is a visual display and mobile phone detector/alerter fitted in the vehicle that can determine if a visual display or mobile phone is being used. This system would then issue a warning signal on the exterior of the vehicle that alerts Police to the fact that a visual display or mobile phone is being used in a vehicle so that they can investigate further. Mobile phone alerters are currently used in hospitals, where mobile phone signals can interfere with medical equipment.

A mobile phone/visual display alert system would merely alert Police to the fact that a mobile phone or visual display is being used in the vehicle. It would then be up to the Police to determine if the visual display is located in the correct position or, in the case of mobile phones, if it is the driver or a passenger using the phone and if the phone is hand-held or hands-free. Also, in the case of mobile phones, while the system could be designed to be automatically disabled if the phone was being used as part of a hands-free cradle-mounted system, it would be difficult for the system to detect if other hands-free modes, that are not connected to the vehicle (e.g., headsets), were being used and thus disable the warning.

5.2.7 Licensing and Registration

Automatic Licence Plate Recognition Systems

Automatic licence plate recognition (ALPR) systems automatically detect and read the registration/licence plates of vehicles that pass the system's cameras and look up vehicle and owner details in a database. The operation of ALPR systems was discussed in Section 4.2.2 of the previous chapter. ALPR systems can be used by the Police to automatically detect a range of registration and licensing offences such as vehicles with expired registration and owners who have been disqualified from driving. ALPR systems can also be used to enforce other types of crime (e.g., notify Police that a vehicle owner is wanted for other, non-traffic offences). ALPR systems fitted to Police vehicles would prevent Police from having to manually enter vehicle licence plate information into their on-board system, decreasing their chance of being involved in a distraction-related incident. ALPR systems are increasingly being used by Police world-wide to assist traffic enforcement. Currently, however, ALPR systems may not be capable of detecting the licence plates of some vehicles, namely motorcycles, as these vehicles are, at present, not required to be fitted with front licence plates and the rear licence plates are smaller than those fitted to other vehicles. To the knowledge of the authors, no studies on ALRP have examined the feasibility or accuracy of using ALPR system to read the smaller licence plates on motorcycles in Australia.

Electronic Licences

Electronic licences or keys could be programmed so that they prohibit disqualified or unlicensed drivers from starting a vehicle. They could also be used to prevent drivers from driving outside the conditions of their licence (e.g., preventing drivers with a curfew from driving during certain hours or from driving certain vehicle types). Electronic licences could be linked to their owners in order to prevent people from using another driver's licence to start the vehicle, by requiring drivers to input a PIN number or scan their fingerprint when they enter the vehicle.

Engine Readers

In the Stage 2 focus group, the Police members highlighted that they often have difficulty establishing if the allowable power-to-weight ratio of some vehicles had been exceeded for certain driver groups, namely probationary drivers. The members at the Stage 3 workshop noted that one solution to this problem would be to equip the engine readers currently used on heavy vehicles to passenger vehicles in order to detect if the maximum power to weight ratio allowed for probationary drivers has been exceeded. Engine readers could also be coupled with the use of electronic licences to first identify the driver and determine what the maximum allowable power-to-weight ratio is, and then determine if this ratio has been exceeded. If the ratio has been exceeded, then the systems can prevent the vehicle from starting.

Speed and Acceleration Limiting Devices

Speed and/or acceleration limiting devices could also be fitted to probationary licence holders' vehicles to prevent them from travelling above certain speeds even if their vehicle is, or has been modified to be a high-powered vehicle.

5.2.8 Heavy vehicles – Mass dimensions and driving hours

A number of technologies exist or could be developed to enforce heavy vehicle weight and dimension limits and compliance with prescribed heavy vehicle speed limiting restrictions.

Weight and Dimension Measuring Stations

Weigh-in-motion stations and vehicle length measuring devices could be installed at a greater number of locations to detect violations of heavy vehicle mass and dimension limits. Cameras or ALPR systems could also be linked to these measuring stations to identify vehicles that exceed the maximum weight and dimension limits and issue infringement notices to the vehicle owner, driver or other responsible party.

Driving Hours Loggers

Determining if heavy vehicle drivers have exceeded the number of prescribed driving hours can currently be difficult to establish. The Safe-T-Cam initiative in New South Wales is an automated monitoring system that can verify driver log books and identify drivers that have travelled beyond the prescribed driving hours, as well as identifying heavy vehicles that have travelled at excessive speeds, are unregistered or have failed to enter a checking station for inspection. The Safe-T-Cam network consists of 24 digital cameras at various locations on major truck routes throughout NSW and at heavy vehicle checking stations. The Safe-T-Cam technology has attracted interest from overseas and could be used more widely on the Australian road network to help enforce a range of heavy vehicle traffic laws.

Electronic log books and electronic licences could also be used to record heavy vehicle drivers' driving hours. Electronic log books would record the start and end time of each trip as well as the number and duration of any rest breaks taken. The data from the system could then be downloaded and checked at inspection stations or by Police if they intercept the vehicle. The electronic licence could also be used to distinguish between drivers' data for vehicles that may be driven by multiple drivers.

Speed Limit Compliance Technologies

The participants at the workshop suggested that a speed limiter tamper detection device could be developed that could be used by Police to detect if the speed limiter is operating correctly. While the specific details of such a system were not discussed at the workshop, the system would ideally be easily carried around in a Police squad vehicle, be capable of quickly detecting any signs of tampering with the speed limiter enabling usage at inspection stations and during roadside intercepts.

5.2.9 Bicyclists and Motorcyclists

The Police members noted that it is often difficult to intercept motorcyclists because they can usually travel at higher speeds than Police vehicles through traffic. Limiting Intelligent Speed Adaptation is one system that could assist Police in intercepting motorcyclists because it limits the speed at which the motorcyclist can travel. Unless such a technology is made compulsory, however, it is unlikely that many motorcyclists would equip a speed limiting system to their motorcycle, given that such a system may restrict their ability to move through the traffic and onto clearer roads.

5.2.10 Detection of violations

One of the key issues that derived from the Stage 2 focus group was that the Police rely on visual inspection to detect many traffic violations. A range of technologies exist that could automatically detect traffic violations and identify offending vehicles without the Police having to be present.

Closed Circuit Television

Closed Circuit Television (CCTV) could be installed at various locations on the road network to monitor driver behaviour and detect a range of traffic violations, such as travelling in restricted lanes, illegal overtaking, failing to give way to other road users, using hand-held phones and not wearing a seatbelt or motorcycle helmet. CCTV could be linked to imaging technology or automatic vehicle identification systems in order to automatically detect if drivers are not wearing a seatbelt or are travelling in a lane reserved for other vehicle types and identify the vehicle and/or the driver.

In-vehicle Event Data Recorders

In-vehicle event data recorders could also be used to help Police detect traffic violations. Event data recorders could be linked to a GPS receiver on the vehicle to establish vehicle location and programmed to record certain driving data such as speed and following distance. The system could thus record violations such as excessive speeds in certain locations, which Police can then access to verify that an offence occurred. The use of event data recorders could also deter drivers from violating road rules in the first place because they know their driving behaviours are being recorded.

ALPR Systems and Electronic Vehicle Identification

Two technologies that can automatically identify vehicles once they have been detected violating traffic laws are the ALPR systems and Electronic Vehicle Identification (EVI) systems. ALPR systems automatically ‘read’ the licence plate of vehicles to identify the vehicle. Electronic Vehicle Identification has been proposed as a future way of identifying individual vehicles and communicating with them. EVI devices identify vehicles using a wireless communication link to read an electronic tag located on the vehicle that contains unique vehicle information. This electronic tag can be located almost anywhere on the vehicle and can transmit vehicle information such as registration number, vehicle identification (VIN) number, vehicle make, model and dimensions, and vehicle classification category (Stevens & Stoneman, 2002). EVI can be used in a range of applications including traffic law enforcement, by automatically identifying vehicles that are speeding, running red lights, tailgating, or travelling in restricted lanes (Staudinger, 2003). Electronic tag readers could be linked to speed and red light cameras, for example, and activated when a vehicle is detected exceeding the speed limit or running a red light.

System designers and researchers claim that the use of EVI has a number of advantages over automatic licence plate recognition systems, namely being able to detect every vehicle passing the reader unit unlike licence plate recognition systems which cannot read all licence plates under certain lighting conditions or if the plate is dirty. However, EVI systems do require tags to be placed on the vehicle (like the Victorian CityLink “e-Tags”), either at the time of manufacture or as a retrofitted device, which increases the cost of these systems.

5.2.11 Intercepting Vehicles

Intercepting vehicles that have been detected committing a driving offence, particularly motorcyclists, was deemed by the Police members to be a difficult and sometimes dangerous task. A number of technologies now exist that could help Police intercept vehicles more safely. These include remote vehicle stopping and vehicle tagging and tracking devices.

Remote Vehicle Stopping Devices

Remote vehicle stopping technology has been in existence for a number of years, but only in a rudimentary form (Hammond & Rooke, 2003). Some of the more advanced forms of remote vehicle stopping that have been proposed or are under development include remote engine immobilisation, remote vehicle speed governing to reduce the vehicle to the speed limit or some other limit, and remote vehicle stopping in a controlled way. Remote engine immobilisation works by preventing the vehicle from being restarted once the system has been activated and the engine has been switched off. Engine immobilisation could also be coupled with a vehicle tracking device so that Police can track the vehicle at a safe distance. A remote speed governing device that limits the vehicle to the local speed limit would require the system to be linked with a GPS system and digital road map containing the speed limits, as well as a vehicle tracker. This technology would work by reducing vehicle speed to a point where Police would be able to more safely intercept the vehicle without the danger of a high speed pursuit. Remote vehicle stopping technology would, similarly, allow Police to reduce vehicle speed in a controlled manner to bring it to a stop without endangering the safety of the driver or other road users. Remote vehicle stopping technologies have the potential to reduce the number and duration of Police pursuits (Hammond & Rooke, 2003). A major drawback of these technologies is that they require vehicles to be equipped with an engine immobiliser and/or GPS transmitter, which many vehicles on the road are not equipped with. It is also possible that remote vehicle speeding governing and stopping devices may lead drivers to engage in dangerous driving behaviours other than speeding to avoid Police.

Vehicle Tagging and Tracking Devices

An alternative to remote vehicle immobilisation technology is vehicle tagging and tracking technology. A real-time vehicle tagging and tracking device called StarChase has been developed during 2006 in the US that is capable of tracking offending vehicles in real-time. The system consists of an adhesive vehicle tracking dart containing a GPS receiver, radio transmitter and power supply that is fired by Police from a compressed-air launcher onto an offending vehicle. The launcher can be a hand-held device or mounted on the front of a Police vehicle. The offending vehicle’s position is determined via GPS and wirelessly transmitted to the Police where they can track the vehicle in real-time. The StarChase device is currently being trialled by the Los Angeles Police Department in the US.

5.2.12 Infringement Processing

One of the main concerns raised by the Police members during the Stage 2 focus group was that they have to spend a significant proportion of their work time processing infringement notices and completing paperwork. There was concern among the members that one of the side-effects of introducing more automated enforcement technologies would be the increase in paper work required to process the greater number of traffic violations detected. The problems associated with the lack of a fully automated enforcement chain have been recognised and technologies are being developed to automate not just the detection of traffic violations, but also the processing of infringement information.

Technologies have already been implemented by Police in Australia and other countries to speed up the process of accessing vehicle and driver data and issuing tickets. In Queensland for example, a system called the MINDA (Mobile Integrated Network Data Access) mobile data unit has been implemented that allows Police real-time access to a database containing registration, licensing and outstanding traffic infringement details. The MINDA system allows Police to access vehicle and driver data in four seconds, rather than the 15 minutes it previously took for data retrieval. The National Highway Traffic Safety Administration in the US has also developed an advanced ticket issuing machine that obtains driver data from the magnetic strip on driver's licences and prints infringement notices on site. While these technologies reduce the time needed to access driver data and issue infringement notices, the procedure involved in processing infringement notices and updating driver records is still time consuming. A number of technologies have also been, or are being, developed to reduce the amount of manual processing required by Police.

Automatic Vehicle Identification Devices

The use of ALPR and electronic vehicle identification technologies has the potential to reduce infringement processing time by removing the need for officers to manually obtain and verify vehicle details from an image produced by a speed, red light, or other enforcement camera. These technologies will allow vehicle details to be automatically obtained at the time of the offence and transmitted to the Police or a central processing agency.

Mobile Data Entry Terminals

Devices called Mobile Data Entry Terminals are currently being developed to assist in the collection and processing of traffic infringement data. These devices could allow enforcement officers to directly input infringement details into a database system so that driver's records are automatically updated at the scene. This would mean that Police would not have to return to the office to input infringement details. One concern with the use of mobile data entry terminals, however, is that errors or omissions could be made when entering offence details and, hence, a process would have to be introduced whereby entries are monitored for inaccuracies (PACTS, 2005). One solution to the problem of data omissions would be to have a number of items that are required to be filled in before the system will allow Police to submit the offence record to the database. Mobile Data Entry Terminals are currently under development.

Automated Infringement Processing Software

Police departments in a number of countries around the world have implemented fully automated infringement processing systems that could be examined by Australian Police departments for potential use. France, for example, now relies solely on digitised infringement information from the violation detection phase through to the sending of the infringement notice to drivers, meaning that all the infringement processing is done without any human intervention except for verification of details in some exceptions (Chevreuil & Canel, 2003). Police departments in The Netherlands also use fully automatic 'back-office' processing, enabling them to process infringement within days instead of weeks (Korevaar & van der Berg, 2004). Finally, New York State Police are implementing the TraCS (Traffic and Criminal Software) system, which is an automated data collection system, that allows Police to issue electronic tickets and send crash and infringement data electronically to a central processing repository (www.tracs.trooper.state.ny.us).

5.2.13 Evidence of Offence

Police are often required to provide evidence in court that a traffic offence occurred if a driver contests an infringement notice. Speed and red light cameras obtain an image of the offending vehicle, but, in many cases, the Police have no photographic evidence that a traffic offence occurred and it comes down to a matter of the Police's word against the driver's. Technologies are available that can provide photographic or video evidence of traffic violations. The Victorian Police will soon equip forward facing in-vehicle video recorders in Police vehicles that will record motorists' traffic offences. This will allow Police to play back the violation to drivers and will, theoretically, reduce the number of motorists contesting their infringement notices.

Another technology that could assist Police in obtaining evidence of traffic violations is in-vehicle Event Data Recorders. These systems are capable of recording a number of vehicle parameters and could be used, for example, to obtain data regarding whether a vehicle was speeding at the time of a crash. There are, however, privacy issues surrounding the collection and use by Police of the data recorded by Event Data Recorders and some of the other technologies reviewed here, including who owns the data and who should be allowed access to it. At present, there are also no standards governing the design of Event Data Recorders and this may have implications regarding what vehicle parameters are recorded and how easy it is to access the data (PACTS, 2005).

5.3 Summary

There exists a range of new and existing ITS and telematics technologies that could be used to assist Police enforcement of traffic laws and help overcome some of the difficulties Police currently experience when enforcing certain road rules. The technologies identified can be used to assist Police at all points along the traffic enforcement chain, from detecting traffic violations to processing infringement notices and providing photographic or video evidence of the traffic offence. The technologies identified also have the ability to prevent or deter drivers from engaging in illegal and dangerous driving behaviour in the first place, thereby increasing safety and reducing the need for Police intervention. The following chapter will discuss some of the issues surrounding the use of automated enforcement.

6 DISCUSSION AND CONCLUSIONS

Traffic enforcement is a multi-dimensional issue involving not just detection of traffic violations, but also interception of offending drivers, processing of infringements and, in some instances, providing evidence that an offence occurred. New and existing ITS and telematics technologies have been identified that can support Police traffic enforcement at each of these levels and also help prevent drivers from committing traffic violations in the first place.

Road traffic enforcement is an important element of road safety that can have a large impact on reducing road trauma. The use of automated enforcement technologies can improve the effectiveness, accuracy and efficiency of police traffic enforcement activities by increasing the actual and perceived chance of traffic violations being detected without increasing the number of police resources required and by encouraging drivers to comply with traffic laws. Automated enforcement also has a number of other benefits over traditional enforcement measures including providing evidence (e.g., photographic) that a violation has been committed and by simplifying the process of producing infringement notices It is therefore not surprising that research shows that there is a trend towards the adoption of automated traffic enforcement technologies around the world.

While ITS and telematics technologies have the potential to enhance the effectiveness of Police traffic enforcement activities and, thus, contribute to road safety, there are a number of challenges that need to be addressed before many of the identified technologies can be implemented. These challenges relate to the development and installation of supporting infrastructure for enforcement technologies, issues relating to the acceptability to Police and the wider community of enforcement technologies, privacy and legal issues, financial and uptake issues, and extensive testing of enforcement technologies prior to deployment to ensure they are accurate, reliable and pose no safety risks to road users.

6.1 Support Infrastructure

In order to operate effectively, many of the identified enforcement technologies will require a range of supporting infrastructure, including databases, equipment and support agencies. Technologies such as Intelligent Speed Adaptation, for example, will require a range of supporting infrastructure including a central database where permanent and temporary changes to speed limits and road additions are updated and transmitted to drivers. Automatic vehicle identification technologies, such as ALPR and electronic vehicle identification, will also require extensive infrastructure such as the development and fitment of electronic vehicle tags to every vehicle, and tag and licence plate readers.

An increase in the use of automated enforcement is also likely to result in an increase in the number of traffic violations detected and, hence, the amount of traffic infringements that need to be processed. Any increase in the use of automated violation detection technologies would also need to be accompanied by the implementation of automated infringement processing software to avoid overloading the Police with paperwork.

6.2 Police and Public Acceptance

Support for the introduction of enforcement technologies by both the Police and the general community will be essential to the success of these technologies. The Police members noted during the focus group that they are supportive of using technology to assist them in enforcing traffic laws, but that they would not want traffic enforcement to become overly automated. In particular, the Police noted that automated enforcement, in which drivers receive an infringement notice in the mail several days or weeks after the offence, may not have the same deterrence effect as being intercepted by a traffic officer and being issued with an on-the-spot fine.

Public acceptance of automated enforcement technologies is also crucial to their effectiveness. Public acceptance is particularly crucial for those technologies that are required to be purchased by consumers, such as speed, following distance and seatbelt warning systems (Regan, Mitsopoulos, Haworth & Young, 2002). One of the main aims of traffic enforcement is to discourage illegal and unsafe driving behaviour and, thus, reduce road trauma. If driver acceptance of enforcement technologies is low, then the deterrence effect of these technologies is also likely to be low and drivers are going to be less likely to purchase technologies such as Intelligent Speed Adaptation, or use them in the correct manner. Providing evidence of reliable and accurate enforcement technology will be an important step in ensuring driver acceptance of these devices. Communication and education regarding the use and benefits of enforcement technologies will also be important for increasing their acceptance.

Extensive acceptability testing of automated enforcement technologies with the general public and wider range of police will be required prior to wide-scale implementation of any of these systems. Education campaigns should also accompany the introduction of new enforcement technologies to inform the public of their use, benefits and accuracy.

6.3 Evaluation and Testing

Extensive testing will need to be carried out on enforcement technologies prior to deployment to establish their accuracy and reliability and ensure they pose no safety risks to road users. The impact of the technologies would also need to be evaluated after their deployment to determine how effective they are in deterring illegal driving behaviour and reducing crashes.

6.4 Legal and Privacy Issues

A number of legal privacy issues surround the use of some of the identified enforcement technologies. Current legislation prohibits the use of some technologies such as mobile phone signal jammers. There are also a number of privacy issues surrounding access to driving data in the event of a crash or traffic offence, particularly from in-vehicle Event Data Recorders. It is not clear at this stage who owns the data from these devices (e.g., the Police or driver) and who should have access to the data and under what conditions. Such legal and privacy issues would need to be resolved for the implementation of some of the identified technologies to be possible or successful. This can often be difficult given that legislative changes often do not keep pace with developments in technology.

6.5 Financial and Market Uptake Issues

There are a number of financial and market uptake issues surrounding the implementation of some of the identified enforcement technologies and these can differ across in-vehicle and infrastructure-based technologies. First, it can take a number of years for in-vehicle technologies to fully infiltrate the entire vehicle fleet and these timelines are extended further if mandatory usage and retro-fitting of the technology to existing vehicles is not required. On the other hand, the full implementation of infrastructure-based technologies, once installed, has an immediate impact on the entire vehicle fleet. Second, while government and private companies typically cover the costs of installing and maintaining road-based enforcement equipment, it is not clear who will be required to pay for the purchase and installation of in-vehicle technologies and the maintenance of the supporting infrastructure – the government or the individual drivers. This depends on the regime under which the technology is implemented. Requiring individual drivers to purchase these technologies with little or no government subsidisation could reduce the acceptability of these technologies to them and, if implemented on a voluntary basis, result in fewer drivers purchasing the systems.

6.6 Prioritising Enforcement Technologies

The current project sought to identify new and existing ITS and telematics technologies that could be used by Police to assist them enforce traffic laws. No attempt was made to prioritise the identified technologies in terms of which ones are likely to address the most critical or largest road safety problems and, thus, determine which technologies should be the focus of initial automated enforcement initiatives. For instance, the Police identified a range of enforcement issues during the project, but it was beyond the scope of the project to determine which of these enforcement categories are the most critical to road safety. It is likely that some of the identified enforcement categories would have little impact on road safety if the enforcement of them was supported by technology, while others would have a large impact. A review of crash databases should be undertaken to prioritise which automated enforcement technologies should be targeted first for adoption and implementation.

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APPENDIX A: LIST OF SAFETY CRITICAL ROAD RULES AND REGULATIONS

1. Speeding

Victorian Road Rules – 1999

Rule 20	Obeying the speed limit
Rule 22	Speed-limit in a speed-limited area
Rule 23	Speed-limit in a school zone
Rule 24	Speed-limit in a shared zone
Rule 25	Speed-limit elsewhere

2. Driving under the influence of Alcohol and Other Drugs

Road Safety Act – 1986

Section 49	Offences involving alcohol or other drugs
Section 50AAD	Offences and immobilisation orders
Section 51	Immediate suspension of licence or permit in certain circumstances
Section 52	Zero blood or breath alcohol

3. Seatbelt Wearing

Victorian Road Rules – 1999

Rules for drivers

Rule 264	Wearing of seatbelts by drivers

Rules for passengers

Rule 265	Wearing of seatbelts by passengers 16 years old, or older
Rule 266	Wearing of seatbelts by passengers under 16 years old

4. Giving Way

Victorian Road Rules – 1999

Giving way at intersections

Rule 67	Stopping and giving way at stop sign or stop line at an intersection without traffic lights
Rule 68	Stopping and giving way at a stop sign or stop line at other places
Rule 69	Giving way at a give way sign or give way line at an intersection
Rule 70	Giving way at a give way sign at a bridge or length of narrow road
Rule 71	Giving way at a give way sign or give way line at other places
Rule 72	Giving way at an intersection (except a T-intersection or roundabout)
Rule 73	Giving way at a T-intersection

Giving way entering road/road related area

Rule 74	Giving way when entering a road from a road related area or adjacent land
Rule 75	Giving way when entering a road related area or adjacent land from a road

Keeping clear of & giving way to vehicles

Rule 76	Keeping clear of trams travelling in tram lanes, etc.
Rule 77	Giving way to buses
Rule 78	Keeping clear of police and emergency vehicles
Rule 79	Giving way to police and emergency vehicles

Crossings & shared zones

Rule 80	Stopping at a children’s crossings
Rule 81	Giving way at a pedestrian crossing
Rule 82	Overtaking or passing a vehicle at a children’s crossing or pedestrian crossing
Rule 83	Giving way to pedestrians in a shared zone

Other give way rules

Rule 84	Giving way when driving through a break in a dividing strip
Rule 85	Giving way on a painted island
Rule 86	Giving way on median turning bays
Rule 87	Giving way when moving from a side or shoulder of the road or median strip parking area
Rule 148	Giving way when moving from one marked lane or line of traffic to another marked lane or line of traffic
Rule 149	Giving way when lines of traffic merge into a single line of traffic

Level crossings

Rule 121	Stopping and giving way at a stop sign at a level crossing
Rule 122	Giving way at a give way sign or give way line at a level crossing
Rule 123	Entering a level crossing when a train or tram is approaching etc

Passing trams

Rule 160	Passing or overtaking a tram that is not at or near the left side of a road
Rule 161	Passing or overtaking a tram that at or near the left side of a road
Rule 162	Driving past a safety zone
Rule 163	Driving past the rear of a stopped tram
Rule 164	Giving way to pedestrians crossing the road near a stopped tram

5. Turning and Signalling

Victorian Road Rules – 1999

Making turns

Rule 27	Starting a left turn from a road (expect a multi-lane road)
Rule 28	Starting a left turn from a multi-lane road
Rule 29	Making a left turn as indicated by a road marking
Rule 31	Starting a right turn from a road (expect a multi-lane road)
Rule 32	Starting a right turn from a multi-lane road

Rule 33	Making a right turn
Rule 34	Making a hook turn at a hook turn only sign
Rule 35	Optional hook turn by a bicycle rider
Rule 36	Bicycle rider making a hook turn contrary to no hook turn by bicycles sign
Rule 38	Giving way when making a U-turn

Change of direction signalling

Rule 46	Giving a left change of direction signal
Rule 48	Giving a right change of direction signal
Rule 50	How to give a right change of direction signal by giving a hand signal

Stop signals

Rule 53	Giving a stop signal

6. Lane Keeping

Victorian Road Rules – 1999

Keeping to the left

Rule 129	Keeping to the far left side of a road
Rule 131	Keeping to the left of oncoming vehicles
Rule 132	Keeping to the left of the centre of the road or the dividing line
Rule 135	Keeping to the left of a median strip
Rule 136	Driving on a one-way service road

Marked lanes or lines of traffic

Rule 146	Driving within a single marked lane or line of traffic
Rule 150	Driving on or across a continuous white edge line
Rule 152	Complying with overhead lane control devices

Rule 153	Bicycle lanes

7. Overtaking

Victorian Road Rules – 1999

Rule 140	No overtaking unless safe to do so
Rule 142	No overtaking to the right of a vehicle turning right etc
Rule 143	Passing or overtaking a vehicle displaying a do not overtake turning vehicle sign
Rule 144	Keeping a safe distance when overtaking
Rule 145	Driver being overtaken not to increase speed

8. Keeping a safe following distance

Victorian Road Rules – 1999

Rule 126	Keeping a safe distance behind vehicles
Rule 127	Keeping a minimum distance between long vehicles

9. Obeying traffic signals and signs

Victorian Road Rules – 1999

Traffic lights

Rule 56	Stopping for a red traffic light or arrow
Rule 57	Stopping or a yellow traffic light or arrow
Rule 59	Proceeding through a red traffic light
Rule 60	Proceeding through a red traffic arrow
Rule 61	Proceeding when traffic lights or arrows at an intersection change to yellow or red

Rule 62	Giving way when turning at an intersection with traffic lights
Rule 63	Giving way at an intersection with traffic lights not operating or only partly operating
Rule 64	Giving way at a flashing yellow traffic arrow at an intersection
Rule 65	Giving way at a marked foot crossing (except at an intersection) with a flashing yellow traffic light
Rule 66	Stopping for twin red lights (except at level crossings)

Traffic signs at intersections

Rule 88	Left turn signs
Rule 89	Right turn signs
Rule 90	No turns signs
Rule 91	No left turn and no right turn signs
Rule 92	Traffic lane arrows

General traffic signs

Rule 93	No overtaking or passing signs
Rule 94	No overtaking on bridge signs
Rule 95	Emergency stopping lane only signs
Rule 97	Keep clear markings
Rule 98	One-way signs
Rule 99	Keep left and keep right signs
Rule 100	No entry signs
Rule 101	Hand-held stop signs

Large vehicle signs

Rule 104	No trucks signs
Rule 105	Trucks must enter signs
Rule 106	No buses signs
Rule 107	Buses must enter signs
Rule 108	Trucks and buses low gear signs

10. Illegal stopping and parking

Victorian Road Rules – 1999

Stopping

Rule 170	Stopping in or near an intersection
Rule 175	Stopping on or near a level crossing
Rule 176	Stopping on a clearway
Rule 183	Stopping in a bus zone
Rule 187	Stopping in a bus lane, tram lane, transit lane, truck lane or on tram tracks
Rule 190	Stopping in or on a safety zone
Rule 191	Stopping near an obstruction
Rule 192	Stopping on a bridge or in a tunnel etc
Rule 193	Stopping on a crest or curve outside a built-up area
Rule 194	Stopping at or near a bus stop
Rule 195	Stopping at or near a tram stop

Parking

Rule 189	Double parking
Rule 212	Entering and leaving a median strip parking area

11. Use of technology in vehicles

Victorian Road Rules – 1999

Rule 299	Television receivers and visual display units in motor vehicles
Rule 300	Use of hand-held mobile phones

12. Careless/Reckless driving

Road Safety Act - 1986

Section 64	Dangerous driving
Section 65	Careless driving
Section 68	Speed trials
Section 68A	Unauthorised use of freeway

13. Licensing and Registration

Road Safety Regulations (Vehicles) – 1999

Number plates

Reg. 221	Affixing number plates
Reg. 801	False or altered number plates and labels

Registration

Reg. 223	Registration labels
Reg. 242	Expiring of registration
Reg. 244	Mandatory suspension of registration of speeding heavy vehicles
Reg. 246	Cancellation of registration
Reg. 246A	Cancellation of registration of written-off vehicles

Written-off vehicles

Reg. 234B	Obligations of insurers and self-insurers to report write-offs
Reg. 234C	Obligations of motor wreckers to report write-offs
Reg. 234D	Obligations of motorcar traders to report write-offs

Vehicle defect notices

Reg. 702	Use of vehicle in breach of notice conditions

Road Safety Regulations (Drivers) - 1999

Learner/probationary drivers

Reg. 211	Vehicle power restrictions
Reg. 212	Restrictions affecting learner drivers
Reg. 219	Passenger restriction for probationary driver licences

License cancellation

Reg. 301	Notification of too many demerit points
Reg. 302	Variation, suspension or cancellation of driver licence

Road Safety Act - 1986

Registration

Section 7	Offence if vehicle or trailer not registered

Licensing

Section 18	Offence if driver not licensed
Section 19	Driver licences
Section 24	Cancellation, suspension or variation of licences and permits by Corporation
Section 30	Offence to drive while disqualified etc
Section 32	Offence to employ unlicensed driver

14. Towing and Loads

Victorian Road Rules – 1999

Rule 216	Towing a vehicle at night or in hazardous weather conditions
Rule 294	Keeping control of a vehicle being towed
Rule 295	Motor vehicle towing another vehicle with a towline

Road Safety Regulations (Vehicles) – 1999

Reg. 802	Offence not to have load properly secured
Reg. 803	Towing offences
Reg. 804	Offence to travel by vehicle where a posted mass or dimension limit would be exceeded
Reg. 805	Offence for vehicle to travel where height restriction would be exceeded

15. Heavy vehicles – Mass dimensions and driving hours

Road Safety Regulations (Vehicles) – 1999

Mass & dimension offences

Reg. 417	Offence to use on a highway a vehicle that does not comply with a relevant mass limit
Reg. 418	Offence to use on a highway a vehicle that does not comply with a relevant mass limit
Reg. 419	Offence to use on a highway a vehicle in contravention of other requirement
Reg. 506	Failure to comply with a mass or dimension limit or other requirement set out in Schedule 1
Reg. 507	Offences for failing to comply with pilot vehicle requirements
Reg. 508	Failure of escort vehicle to comply with a relevant requirement set out in Schedule 1
Reg. 514	Failure to comply with a mass or dimension limit or other requirement set out in Schedule 2

Reg. 520	Failure to comply with a mass or dimension limit or other requirement set out in Schedule 3

Speed limiting

Reg. 155	Speed limiting

Road Safety Regulations (Drivers) - 1999

Driving hours for large vehicles

Reg. 505	Maximum working time – commercial bus drivers
Reg. 506	Minimum rest time – commercial bus drivers
Reg. 508	Maximum working time – heavy truck drivers
Reg. 508A	Minimum rest time – heavy truck drivers

Road Safety Act - 1986

Mass, dimension and load requirements

Section 168	Person must comply with a direction and conditions
Section 178	Penalties applying to offences under this Division and exclusion of double jeopardy

16. Bicyclists and Motorcyclists

Victorian Road Rules – 1999

Rules for bicyclists

Rule 247	Riding in a bicycle lane on a road
Rule 252	No bicycles signs and markings
Rule 253	Bicycle riders not to cause a traffic hazard
Rule 255	Riding too close to the rear of a motor vehicle
Rule 256	Bicycle helmets
Rule 258	Equipment on a bicycle

Rule 259	Riding at night
Rule 260	Stopping for a red bicycle crossing light
Rule 261	Proceeding when bicycle crossing lights change to yellow or red

Rules for motorcyclists

Rule 270	Wearing motorbike helmets

17. Trams and Buses

<u>Victorian Road Rules – 1999</u>

Trams at tram lights

Rule 274	Stopping for a red T light
Rule 275	Stopping for a yellow T light
Rule 277	Proceeding after stopping for a red or yellow T light
Rule 279	Proceeding when a white T light or traffic arrow is no longer showing

Public buses at bus lights

Rule 281	Stopping for a red B light
Rule 282	Stopping for a yellow B light
Rule 284	Proceeding after stopping for a red or yellow B light
Rule 285	Proceeding when a red traffic light and a white B light or white traffic arrow is showing
Rule 286	Proceeding when a white B light or white traffic arrow is no longer showing