AP-R415-12

AUSTROADS RESEARCH REPORT

Point–to-Point Speed Enforcement



Austroads

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Published September 2012

Point-to-Point Speed Enforcement

ISBN 978-1-921991-42-4

Austroads Project No. SS1649

Austroads Publication No. AP-R415-12

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Point-to-Point Speed Enforcement

Austroads
Sydney 2012

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- provide expert technical input to national policy development on road and road transport issues
- promote improved practice and capability by road agencies.
- promote consistency in road and road agency operations.

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- Main Roads Western Australia
- Department of Planning, Transport and Infrastructure South Australia
- Department of Infrastructure, Energy and Resources Tasmania
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ABBREVIATIONS

#	
3G	3rd generation mobile telecommunications
A	
AA	Automobile Association
AC	Alternating current
ACO	Asset Confiscations Operations
ACPO	Association of the Chief of Police Officers
ACT	Australian Capital Territory
ADSL	Asymmetric Digital Subscriber Line
ALPR	Automatic Licence Plate Recognition
AMA	Auckland Motorway Alliance
ANPR	Automatic Number Plate Recognition
ASFINAG	Austrian motorway provider
ASPI	Autostrade per l'Italia SpA
ATA	Australian Trucking Association
B	
BBC	British Broadcasting Corporation
BCR	Benefit-Cost Ratio
BDSL	Combination of ADSL and Single-Pair High-speed Digital Subscriber Line
C	
CARRS-Q	Centre for Accident Research and Road Safety – Queensland
CBA	Cost-benefit analysis
CCTV	Closed Circuit Television
CDMA	Code division multiple access
CJIB	National Executive Authority (Netherlands)
CPU	Central processing unit
CO	Carbon monoxide
CO_2	Carbon dioxide
D	
DC	Direct current
DfT	Department for Transport (United Kingdom)
DOJ	Department of Justice (Victoria)
DPTI	Department of Planning, Transport and Infrastructure (South Australia – formally DTEI)
F	
FEDRO	Swiss Federal Roads Office
FOI	Freedom of Information
G	
GPS	Global Positioning System
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communications
GVM	Gross Vehicle Mass
H	
HA	Highway Agency

HAZMAT	Hazardous Materials
HGV	Heavy Goods Vehicle
HMCS	Her Majesty's Court Services
HOTA	Home Office Type Approval
	I
IMES	Infringement Management and Enforcement Services (Victoria)
IP	Ingress Protection (rating that describes the protection from intrusion of solid and liquid material – level of protection represented by two numbers that follow the letters
	J
JACS	Justice and Community Safety Directorate
JPEG	Joint Photographic Experts Group (Image file type)
	K
KB	Kilobyte
KfV	Kuratorium für Verkehrssicherheit (Austrian Road Safety Board)
KSI	Killed and seriously injured
	L
LED	Light-emitting diode
LHA	Local Highway Authority
	M
MB	Megabyte
MCC	Motorcycle Council of New South Wales
METAS	National Metrology Institute (Switzerland)
MUARC	Monash University Accident Research Centre
	N
NATA	National Association of Testing Authorities
NO_X	generic term for mono-nitrogen oxides (NO [nitric oxide] and NO_2 [nitrogen dioxide])
NRMA	National Roads and Motorists Association (New South Wales)
NSL	National Speed Limit
NTP	Network Time Protocol
NZTA	New Zealand Transport Authority
	O
OAIC	The Office of the Australian Information Commissioner
OCR	Optical Character Recognition
	P
PC	Personal computer
PIA	Privacy Impact Assessment
PIC	Personal Injury Collision
PM_{10}	Particulate matter up to 10 micrometers in size
	Q
QUT	Queensland University of Technology
	R
RAA	Royal Automobile Association (South Australia)
RAC	Royal Automobile Club of Western Australia
RACQ	Royal Automobile Club of Queensland
RACT	Royal Automobile Club of Tasmania

RACV	Royal Automobile Club of Victoria
RMS	Roads and Maritime Services (New South Wales – formally Road and Transport Authority)
RWS	Rijkswaterstaat (Directorate General – Netherlands)
	S
SAPol	South Australian Police
SDRO	State Debt Recovery Office
SNTP	Simple Network Time Protocol
SPECS/SCS	Speed Check Services (now referred to as Vysionics)
STV	Scottish Television
SWOV	Stichting Wetenschappelijk Onderzoek Verkeersveiligheid (Institute for Road Safety Research – Netherlands)
	T
TAC	Transport Accident Commission (Victoria)
TCO	Traffic Camera Office
TIFF	Tagged Image File Format
TIRTL	Transportable Infra-Red Traffic Logger
TRO	Traffic Regulation Order
	U
UHREC	University Human Research Ethics Committee
	V
VAS	Vehicle Activated Sign
VMR	Vehicle Registration Mark
VMS	Variable Message Signs
VSL	Variable Speed Limit
	W
WORM	Write Once, Read Many
	X
XML	Extensible Mark-up Language

GLOSSARY

Term	Definition
Average Speed	Average speed of a vehicle over the ‘shortest practicable distance’ between two ‘point-to-point camera sites’.
Average Speed Limit	The average speed limit applicable to a length of road between two ‘point-to-point camera sites’.
Camera Site (Point-to-Point)	The area where a vehicle can be photographed for use to calculate the vehicle’s ‘average speed’. A ‘point-to-point system’ must involve at least two ‘camera sites’ – one entry ‘camera site’ and one exit ‘camera site’.
Contiguous Enforcement Corridors	‘Point-to-point systems’ involving back-to-back ‘enforcement corridors’ along a stretch of the road network. Each ‘enforcement corridor’ may be operated as an individual ‘point-to-point system’ or the ‘contiguous corridors’ may be linked as a ‘multi-point system’. Typically, the entry ‘camera site’ for the adjacent ‘enforcement corridor’ is situated at the exact same location as the exit ‘camera site’ for the previous ‘enforcement corridor’.
Enforcement Corridor	The section of road between two ‘point-to-point camera sites’ which the ‘average speed’ of a vehicle can be calculated. Enforcement corridors can be contiguous (e.g., adjacent to one another) and will have unique ‘shortest practicable distances’.
Instantaneous Speed	The speed of a vehicle measured at a specific point.
Multi-Point Systems	‘Point-to-point systems’ involving more than one entry and/or exit ‘camera site’. Such systems typically involve ‘cameras’ that are cross-referenced (e.g., each entry/exit ‘camera’ is linked to every other entry/exit ‘camera’). These systems do not necessarily have to involve ‘contiguous enforcement corridors’.
Non-Discrete Speed Zones	Refers to instances whereby the speed limit is not consistent for the entire distance within a single ‘enforcement corridor’ (e.g., where the speed limit changes between an entry ‘camera site’ and exit ‘camera site’).
Point-to-Point Speed Enforcement	An approach to speed enforcement which calculates the ‘average speed’ of vehicles between two ‘point-to-point camera sites’.
Point-to-Point Speed Camera	Detection camera that forms part of a ‘point-to-point speed enforcement system’ and is designed to identify vehicles at ‘point-to-point camera sites’.
Point-to-Point System	A speed camera enforcement system which calculates the ‘average speed’ of vehicles between two ‘point-to-point camera sites’. The system includes technology developed to, among other things, detect vehicles (e.g., ‘point-to-point speed enforcement’) and identify vehicles (e.g., ANPR/OCR software).
Shortest Practicable Distance	The shortest distance that a vehicle can travel, without contravening any road rules applicable to the driver, between the beginning and end of a point-to-point enforcement corridor.

SUMMARY

This report, commissioned by Austroads, reviews the use of point-to-point speed enforcement internationally in order to provide principles for better practice for its use in Australia and New Zealand. Point-to-point enforcement is a relatively new technological approach to traffic law enforcement that has increased in use in a number of highly motorised countries in the last decade. Most commonly implemented to enforce speed limits, the technology has also been used for lane and toll enforcement, access regulation, tracking of stolen vehicles, identification of unlicensed motorists, and counterterrorism activities. This report, however, focuses on the implementation of point-to-point camera enforcement systems for the purpose of monitoring compliance with posted speed limits.

Three major research activities were undertaken for the preparation of this report:

1. An extensive review of the international literature, including an examination of the extent of the use of point-to-point speed enforcement throughout the world and a critical appraisal of empirical studies evaluating the effectiveness of the approach

2. An extensive consultation process with international and domestic stakeholders to explore the use of point-to-point speed enforcement, the technological, operational, and legislative characteristics associated with the technology, and broader speed management and road safety issues within jurisdictions

3. A one-day working group with Australian and New Zealand stakeholders which provided the opportunity to present synthesised results from the first two research activities and facilitated discussion about better practice principles in the use of point-to-point speed enforcement in Australia and New Zealand.

A growing body of evidence suggests a positive relationship between increased vehicle speeds and increased crash risk and injury severity. In Australia and New Zealand, speeding remains a major contributor to traffic crashes and related trauma despite enhanced road and vehicle engineering measures and increases in the intensity in which a wide variety of speed management approaches have been implemented. As noted in the recently released National Road Safety Strategy (2011-2020), there is an ongoing need to manage driving speeds across the road network to promote safer road use. Point-to-point speed enforcement appears to be one tool capable of assisting in meeting this need.

Effects of point-to-point speed enforcement

To date, there have been no formal evaluations of any of the implementations or trials of point-to-point speed enforcement in Australia or New Zealand. The majority of empirical research emanates from the United Kingdom, with a number of evaluations also conducted in the Netherlands, Austria, Italy and France. Although methodological limitations are noted across the majority of the published evaluations, the consistency of positive findings is encouraging. The impact of point-to-point speed enforcement on vehicle speeds, traffic crashes, vehicle emissions, noise and traffic flow have been investigated.

There is considerable evidence indicating a positive influence of the approach on a number of speed measures including: average/mean speeds; 85th percentile speeds; the proportion of speeding vehicles; and speed variability. Evaluations of point-to-point systems have typically reported substantial reductions in mean and 85th percentile speeds associated with the introduction of the technology. Moreover, average (and often even 85th percentile) speeds are reduced to at or below the posted speed limit. Such impacts have been reported in association with both permanent and temporary systems employed in various countries throughout the world. Exceptional rates of

compliance with posted speed limits are also noted, with offence rates typically reported to be less than 1%, even when daily traffic volume is high. Further, the proportion of vehicles exceeding the speed limit is often found to be drastically reduced (upwards of a 90% reduction) and the approach has been noted as particularly effective in reducing excessive speeding behaviour. Reductions in all crash types, particularly fatal and serious injury crashes, have been reported.

An additional benefit associated with point-to-point speed enforcement is more homogenised traffic flow and increased traffic capacity resulting from reduced vehicle speed variability and subsequent increased headway. Fixed and mobile cameras have been found to be associated with a stop-start motion created by acceleration and braking close to camera sites and this has been shown to have a detrimental impact on traffic flow. This issue is largely negated when point-to-point enforcement is used. A number of studies have suggested that due to the improvements in traffic flow, subsequent reductions in traffic noise and harmful vehicle emissions can be attributed to point-to-point speed enforcement, though the evidence is mixed. Overall, research indicates positive attitudes of motorists towards the use of point-to-point speed enforcement and it generally enjoys a higher level of public support than other speed enforcement approaches. Although recognised as an expensive approach to speed enforcement, a number of cost-benefit analyses have demonstrated long term net economic benefits.

Technological overview

Point-to-point enforcement involves the installation of a series of cameras at multiple locations along a road section. As a method of speed enforcement, point-to-point systems capture an image and record the vehicle registration data of each vehicle as it enters the system at the initial camera site. Additional images and data are recorded at subsequent camera sites within the system and matched to the initial data. ANPR and OCR technology are then used to identify vehicle registration details. The average speed of a vehicle is calculated using data collected from at least two points within the system. Specifically, average speed is calculated by dividing the distance between two camera sites by the time taken for the vehicle to travel between those two sites. If the corresponding average speed of a vehicle exceeds the legal posted speed limit for that road section, image and offence data are transmitted to a central processing unit from the local processor via a communication network. While most systems incorporate an enforcement tolerance, the specific threshold employed varies by jurisdiction. While there are capabilities for the back-office of a system to be fully automated, almost all current installations of point-to-point involve some degree of human verification to assess the validity of detected infringements (the closest example of a fully automated system is operated in the Netherlands). Validated offences are subsequently issued with an infringement notice and data on non-offending vehicles are typically erased. The body of this report provides extensive detail on the substantial variation in specific technology and equipment employed in operations of point-to-point speed enforcement internationally. Specifically, information is provided on cameras and illumination mechanisms, infrastructure, processors and servers, ANPR/OCR engine and software, communications networks, and back office/central processing units, as well as on various operational, legislative, and ethical considerations related to implementing point-to-point speed enforcement technology.

Use of point-to-point speed enforcement in Australia & New Zealand

Victoria

Victoria was the first Australian jurisdiction to implement point-to-point speed enforcement. In April 2007, the enforcement approach was implemented on a 54 kilometre stretch of the Hume Highway, involving five camera sites monitoring all vehicle speeds along four contiguous sections of road, although each section works independently. The speed limit remains the same throughout enforcement sections and both forward- and rearward-facing cameras are installed. The system operates overtly and signage (not legislated) advises motorists that they are entering an area where safety cameras are used. The system involves an unpublished enforcement tolerance which is identical to the tolerance enacted for other automated speed enforcement in Victoria.

Recent issues regarding certification of time clocks have been addressed by the addition of a secondary reference system. System accuracy regarding plate matching and identification is high (including for interstate number plates) and any new plate is tested to ensure readability by automated speed detection devices and other safety camera equipment prior to release. Data collected from the system are used to perform vehicle registration checks, although only for vehicles detected exceeding the speed limit. The point-to-point speed enforcement system is legislated under the *Road Safety Act 1986* and *Road Safety (General) Regulations 1999*. The specific provisions under the Act pertaining to point-to-point include: prescribed speed measuring device; definition of data; process of production of printed image; prescribed process; average speed evidence of actual speed; and evidence of road distance. A multiple infringement policy is in place such that only one offence within 10 km/h over the posted speed limit is prosecuted, however multiple infringements are issued in association with offences of greater than 10 km/h over the speed limit. To date there are no evaluations of the Victorian point-to-point speed camera system.

Queensland

Queensland is currently conducting a proof-of-concept phase of point-to-point enforcement for all vehicles. This phase will test system functionality and ensure integration with a new Queensland Police Service back office processing system, prior to use for enforcement purposes. This represents the first installation of the technology for speed enforcement in the state. The system, located on the two-lane Bruce Highway (northbound) between Glass House Mountains and Caloundra, is 14.7 kilometres and the speed limit throughout the section remains constant at 110 km/h. Rearward-facing cameras (pole-mounted at the roadside) monitor both lanes of traffic; a plate camera for each lane and a scene camera covering both lanes. All aspects of the system are managed and operated by organisations affiliated with the Queensland government with no outsourcing of responsibilities to private organisations. There is no legislative requirement for the system to be signed, although there are signs advising the use of speed cameras for road safety prior to and immediately before the end of the system. The decision not to include wording about average speeds on signage took into consideration the capability of the system to measure both average and instantaneous speeds.

Calibration of the system will occur annually, with renewed certificates presented to certify the accuracy of the equipment. In line with other speed measuring devices used, point-to-point systems will be validated every six months and equipment will also undergo regular testing procedures. The Queensland system will use an unpublished enforcement tolerance which will most likely be identical to the tolerance enacted for other automated speed enforcement in the state. A multiple infringement policy is also likely, given that both average and instantaneous speeds may be measured.

Legislative changes are currently tabled in anticipation of further developments of the system which will lead to it becoming enforceable. The point-to-point speed enforcement system employed in Queensland is legislated under the *Transport Operations (Road Use Management) Act 1995*, and more specifically Part 7 – Section 112 to 120A and *Traffic Regulation 1962,* Part 22. The specific provisions under the Acts pertaining to point-to-point include: prescribed speed measuring device; average speed evidence of actual speed; evidentiary provisions; prescribed process; and evidence of road distance. An evaluation of the proof-of-concept phase is proposed and will address the performance of the point-to-point system in isolation, as well as in relation to the overall speed camera program.

New South Wales

Currently, New South Wales has a total of 21 bi-directional lengths of road enforced by point-to-point speed camera systems. The technology only applies to heavy vehicles (vehicles registered above 4.5GVM) and monitors heavy vehicle speeds. The routes were designed to cover the most popular heavy vehicle freight routes in the state. The length of the enforced sections ranges from six kilometres to 75 kilometres in length and the enforced stretches have minimal opportunities for access and egress, particularly near actual camera sites. A number of the systems involve multiple speed limit sections within the enforced corridor. In addition, previous installations of point-to-point speed cameras were trialled for all vehicles in 2005 at three sites and focused on the reliability of the systems to monitor traffic of differing volumes.

Cameras are mounted on purpose-built gantries or roadside camera infrastructure. The specific number of cameras in a particular system is proportional to the number of lanes and directions to be enforced, with one camera per lane/per direction. A number of systems also include a camera for the purpose of monitoring the emergency/breakdown lane. The system uses a GPS clock to synchronise the clocks every three minutes, with a log of the amount of correction recorded. An accuracy rate of 80-90% was reported for the ANPR software; manual checks of all matched incidents are performed. Due to legislative requirements, an average speed enforcement sign is required within 150 metres of the camera, within the detection zone. No specification is made on signage to suggest the enforcement is restricted to heavy vehicles only and there is no repetition of signage throughout the enforcement corridor. As is the case throughout Australia, enforcement tolerance levels are not published.

In 2010, amendments were made to the *Road Transport (Safety and Traffic Management) Acts* and *Regulations 1999 No. 20*, such that Section 43A states that average speed is evidence of actual speed in certain circumstances, with the precise formulae for how average speed and average speed limits are calculated defined and certified. In addition, a number of certificates are required annually for the system, including: Certificate evidence concerning average speed calculations (Section 43A); and certification of detection devices (Section 47A). Legislation also requires monthly testing of average speed detection devices.

South Australia

South Australia currently has two point-to-point speed camera systems which are undergoing user acceptance testing and are pending appropriate legislation to allow for the technology to be used for general enforcement purposes. The first system, on Port Wakefield Road, spans 51.5 kilometres of the 110 km/h rural dual carriageway north of Adelaide. The second site is located on Bridge Road and spans 300 metres of the 60 km/h road. This second installation represents a research and development test site being utilised to assess different vendor systems and will not be used as an enforceable site.

Camera type and configuration differs across systems, although forward-facing cameras are used in all locations. While the Pooraka system is capable of monitoring both average and instantaneous speeds, the Port Wakefield system is only capable of monitoring average vehicle speeds. Data collected by the system are linked to licence and registration databases for owner identification. A suitable and accepted process for clock synchronisation is currently yet to be determined by the responsible authorities. Signage for use with point-to-point speed enforcement will identify that average speed cameras are in operation.

Initial type approval and certification procedures are yet to be determined, but it was reported that all equipment must be tested and certified and be covered by appropriate legislation and regulations. This would include independent specification of the distance between camera sites, legislation regarding an average speed offence, and the traceability of time synchronisation. Decisions regarding multiple infringement policies, enforcement tolerances and signage requirements are also yet to be determined. However, it was reported that enforcement tolerances are unlikely to be different to those adopted for other approaches to automated speed enforcement.

Australian Capital Territory

The first implementation of the technology is planned on a 2.7 kilometre section of Hindmarsh Drive and is scheduled to be operational by late February 2012 (legislation was passed in the ACT Legislative Assembly in September 2011). A second site has also been selected but not yet formally announced (expected to be announced February 2012). The proposed implementations of point-to-point speed enforcement in the ACT are planned for urban areas, a relatively unique situation in the Australian context. A range of traffic and safety related criteria (including speed profiles and crash histories) were fundamental in the selection of sites.

Maintenance schedules, as well as methods to verify and certify the surveyed distance, have been finalised as part of the procurement process. Enforcement tolerances will be equivalent to other safety cameras operating in the ACT. GPS time servers will be used for clock synchronisation, with a certified stopwatch also used to provide independent testing of the accuracy of the system. The system will be designed to capture clear and detailed rear images of all vehicles irrespective of vehicle classification. Protocols are in place to quarantine images if malfunctions are detected. Signage requirements are specified in the legislation, such that a sign is required not more than 100m before each detection point and approximately halfway between detection points. The ACT system will be used for average speed detection only and thus there is no need for a multiple infringement policy.

To accommodate the introduction of the point-to-point speed enforcement systems legislation was passed in the ACT Legislative Assembly in September 2011, and commenced in January 2012. Specifically, legislation covers, among other matters: enabling evidence from the average speed of a vehicle between detection points to be used as evidence that a person committed a speeding offence; defining the shortest distance between the detection points and the methodology used for calculating the average speed of the vehicle (including details of the formula for the calculation of average speed); including notice of intention to challenge things such as the shortest practical distance, the average speed limit and how the average speed was calculated; and defining the concept of an approved average speed detection device.

Western Australia

Currently, Western Australia does not employ point-to-point speed enforcement. WA Police have just completed the final phase of the State Government's $30million enhanced speed enforcement program, which involves new speed and red light cameras, digital hand-held cameras and dual-lens digital cameras. Point-to-point cameras were not included in this program as it is intended to complete the existing program and bed it down before considering further expansion into new areas of technology.

It is considered that while the development and application of point-to-point technology is undergoing significant change in other jurisdictions, WA will maintain a watching brief and consider experience in these jurisdictions.

Tasmania

Tasmanian stakeholders are currently in the process of putting together a business case for the implementation of point-to-point speed enforcement in the state with the intention of the systems to monitor both light and heavy vehicles. A number of preferences were expressed regarding site selection protocols. Mandatory factors are likely to include a constant speed limit throughout the entire length of an enforcement corridor and few (ideally none) opportunities for access and egress within the enforcement corridor or a lack of viable alternative routes to evade the system.

It was reported that a minimum distance between camera sites of 300 metres and a maximum of tens of kilometres would be considered. Further, the proposed scope for the initial rollout of point-to-point systems is limited to average speed enforcement, with an additional capacity to enforce 100 km/h speed limits for heavy vehicles in 110 km/h zones. Any additional functionality, such as linking collected data to licence/registration or criminal databases was not in scope, and would need to be expressly approved by Government.

Specific details regarding equipment, communications systems, certification, maintenance, testing, signage, enforcement thresholds, and multiple infringement policies are yet to be determined. Privacy issues were raised by stakeholders as a significant consideration and it was reported that any project approved by Government will be required to undertake an external, independent Privacy Impact Assessment (PIA) that will identify potential privacy impacts and recommend options for managing, minimising and/or eradicating these impacts. The PIA would then provide the basis for a Privacy Management Plan for the enforcement system.

Northern Territory

Stakeholders in the Northern Territory reported no immediate plans to introduce point-to-point speed enforcement. It was reported that any future implementation would likely focus on border to border tracking of vehicles, given the geographical characteristics of the jurisdiction and the considerable distances between population centres. The capability to monitor vehicles over considerable distances was highlighted as important, given the fact that many routes have few or no exits. It was noted that sites would need to be protected physically and the equipment secured from damage or interference.

New Zealand

Currently, a single trial of point-to-point speed cameras (not enforceable) is being conducted in Auckland at a road works site. Unique challenges to speed enforcement on location were recognised, prompting the trial of this enforcement approach. The road works are being conducted at the Newmarket viaduct (both north and south bound) which is raised 10-15 metres off the ground. The trial is planned to continue for the length of the construction project, which is expected to be completed in early 2012. The trial site will initially involve a one kilometre stretch of the northbound 3-lane section of the viaduct, employing existing gantries to mount the equipment. However, during the course of the trial the monitored section will increase to 1.5 kilometres due to the relocation of one of the gantries. The speed limit along the entire monitored stretch is 70 km/hr. The site will involve a single entry and exit point, with a total of six forward-facing cameras mounted to existing overhead gantries. Rearward-facing cameras were not preferred due to the specific problem associated with spray from vehicle rear tyres during wet road conditions. During the first month of the trial a total of 20 hours per week of manual checks will be conducted to verify the accuracy of the system. Future decisions of the degree of manual verification in back-office proceedings will be based on evidence from this process.

While the specific maintenance schedules had not yet been determined, it was reported that they would likely be conducted at least every six months, with realignment a probable consideration, due to ongoing road construction. GPS will be used to synchronise the time clocks involved in the system as a primary-time reference, with simple network time protocol (SNTP) as a secondary reference. There are currently no plans to link information collected from the system to other databases. Owing to the non-enforceable status of the trial, there is currently no need to address any type approval or certification procedures prior to implementation. However, it was noted that an extensive process would be involved if the device was to become functional in an enforcement capacity.

Additional stakeholder consultations

Apart from the government bodies associated with governance of point-to-point applications in Australia, a range of other stakeholders were consulted to provide information and additional perspectives on this form of speed enforcement. The report contains specific feedback from the following stakeholders: Royal Automobile Club of Queensland; Royal Automobile Club of Victoria; Royal Automobile Club of Tasmania; National Roads and Motorists Association; Royal Automobile Association (South Australia and Western Australia); Motorcycle Council of New South Wales; Australian Trucking Association; National Measurement Institute; Office of the Australian Information Commissioner; and Professor Max Cameron, Monash University Accident Research Centre.

Use of point-to-point speed enforcement internationally

The use of point-to-point speed enforcement can be considered still in its infancy in Australia and New Zealand. However, the approach is more widespread and long-standing in parts of Europe and the United Kingdom. An extensive summary of the status of international and domestic systems is presented in this report, described according to the extent of use; technical, operational and legislative characteristics; and broader speed management issues associated with each jurisdiction. A brief summary is provided here.

In England, point-to-point speed enforcement has increased considerably since its inception via a trial in 1999 in Kent and is now widely used. The first full implementation of the technology occurred in Nottinghamshire in July 2000. The program has expanded into urban areas more recently. Over 210 temporary systems have been operated in major road work schemes as well as 36 permanent installations by one provider and up to 40 temporary systems at road work sites by another provider. In Scotland, there is currently one permanent point-to-point speed camera system on a 51.5 kilometre stretch of rural highway on the A77 in Strathclyde that was first implemented in July 2005. There are also two permanent point-to-point systems operational in Northern Ireland, the first of which was implemented in July 2006 (A1 Newry) and the second in March 2008 (A2 Belfast to Bangor).

Point-to-point speed enforcement was first operated in trial form in 1997 in the Netherlands and then as a permanent installation in 2002. Currently, there are 11 permanent point-to-point speed enforcement locations in the Netherlands, operating with gantry-mounted, rearward-facing cameras that are located on complex road sections. In Austria, the first implementation of point-to-point speed enforcement was on the A22 motorway in the Kaisermühlen tunnel near Vienna in August 2003 in direct response to a number of crashes occurring in the tunnel. There are currently three permanent installations operating, one with variable speed limits of between 80 and 130 km/h and a mobile system is currently used to enforce a one kilometre section of road in roadwork zones on the A12 motorway.

In Italy, two distinct point-to-point enforcement systems are operational (Tutor and Celeritas). The Tutor system, introduced in 2005, covers approximately 2 900 kilometres of the motorway network. Celeritas is less extensively operated across the country and is more commonly used on rural roads. Approximately 200 independent sections of road are monitored; the average length of enforced Tutor sections ranges from two to 40 kilometres. In Switzerland, there are three point-to-point speed enforcement systems (two permanent systems and one a mobile system) though only one of the permanent systems is currently fully operational (since January 2011) while the remaining two are under trial to gain approval.

Belgium is currently trialling one permanent point-to-point system on a 1.9 kilometre stretch of the E17 motorway. In Finland, point-to-point speed enforcement was trialled for a five week period in August/September 2010 on a 5.7 kilometre stretch of an urban single-carriageway highway. In France, there is currently no permanent deployment of point-to-point speed enforcement, although trials were conducted in 2003 (through a section of road works) and 2004 (on a 90 kilometre stretch of motorway), though neither trial involved an enforcement component. Finally, limited information was available on the use of point-to-point speed enforcement in other European countries. However, it also appears that the technology is currently being used or trialled in Norway, and the Czech Republic and trialled in Spain.

Towards best practice: principles for better practice

Based on the findings reported from the stakeholder consultations, working group and literature review, a number of recommendations for better practice are suggested in relation to the development and implementation of point-to-point speed enforcement systems in Australia and New Zealand. These are presented under the headings of: (i) operational recommendations; (ii) technological recommendations; (iii) legislative recommendations; (iv) public education recommendations; (v) evaluation recommendations; and, (vi) privacy recommendations. Page reference numbers are provided for easy access to more detailed information regarding each of the recommendations.

Operational recommendations (pages 127-133)

Recommendation 1: The selection of sites for the implementation of point-to-point speed enforcement should be based on strict criteria aimed at achieving road safety benefits and ensuring cost-effectiveness of the point-to-point speed enforcement systems. Jurisdictions should work together to develop and refine site selection methodologies (page 127).

Recommendation 2: Point-to-point speed enforcement should be strategically used in conjunction with existing automated and manually-operated speed enforcement approaches in order to promote greater compliance with posted speed limits across larger sections of the road network (page 128).

Recommendation 3: Point-to-point speed enforcement should not represent a long-term alternative to addressing underlying road design or maintenance deficiencies on sections of road, which would be better addressed through engineering solutions (page 129).

Recommendation 4: Point-to-point speed enforcement systems should be implemented with the capacity to monitor all vehicle types, even if the initial implementation does not require this capability, and where feasible, should be used to monitor all possible vehicle types (page 129).

Recommendation 5: Point-to-point speed enforcement systems should (continue to) be operated overtly, including: advance signage placed prior to the enforcement corridor that highlights the extended nature of enforcement activities; additional reminder signs located within the enforcement corridor for longer sections (e.g., five kilometres or longer); and, *no* signage to signify the end of the enforcement corridor (page 129).

Recommendation 6: Each jurisdiction should be responsible for managing the enforcement tolerances associated with point-to-point speed enforcement systems according to their own jurisdictional needs (page 130).

Recommendation 7: All jurisdictions should have a multiple infringement policy that clearly stipulates how multiple infringements are dealt with, however such a policy should not necessarily prescribe that only one infringement can be issued for multiple offences (page 130).

Recommendation 8: Police should continue to conduct routine traffic patrols within the enforcement corridor aimed at monitoring illegal, high-risk driving behaviours other than speeding. This is particularly relevant for longer sections (page 131).

Recommendation 9: Excessively long distances between camera sites should be avoided, particularly when there are many opportunities for access and egress within the enforcement corridor. When lengthy enforcement corridors are desired, contiguous enforcement corridors should be used (page 131).

Recommendation 10: The decision to use point-to-point speed enforcement systems on road sections with multiple speed limits should be accompanied by appropriate legislation that includes the identification of an average speed offence and related issues and should be guided by the current context of speed management in the jurisdiction (page 132).

Recommendation 11: Unless contiguous enforcement corridors or multi-point systems are used, point-to-point speed enforcement systems should not be installed along road sections where there are features (e.g., service stations, rest stops, traffic lights) that increase the likelihood that a vehicle will exit the road or be stopped, or not monitored by the system (e.g., exit and entry roads) (page 132).

Recommendation 12: Point-to-point enforcement systems should monitor and enforce all traffic lanes, including, where it is deemed necessary, emergency lanes and traffic lanes travelling in the opposite direction, with penalties associated with attempted avoidance behaviours (page 133).

Recommendation 13: Mobile point-to-point speed enforcement systems should be developed, trialled and evaluated to determine their capability and effectiveness (page 133).

Recommendation 14a: Prior to release, new number plate designs should be tested to ensure existing camera equipment used within the jurisdiction is capable to sufficiently detecting and capturing the plate for enforcement purposes (page 133).

Recommendation 14b: Vehicle number plates should avoid using glossy numerals and letters or a glossy background (page 133).

Recommendation 14c: Identical alpha-numeric sequences should not be used within or across jurisdictions, irrespective of the design of the number plate (page 133).

Technological recommendations (pages 134-137)

The following technological recommendations must be considered in light of the various approaches available and the continually evolving nature of the technology associated with point-to-point speed enforcement systems. That is, it is acknowledged that various approaches to the technological characteristics of point-to-point systems are capable of achieving effective enforcement and appropriate system efficiency in a cost-effective manner. While these recommendations attempt to outline current best practice (based on available information), it is acknowledged that the adoption of alternative approaches do not necessarily reflect poor practice. In addition, it is acknowledged that future advancements and developments in the technology associated with point-to-point enforcement are likely to further enhance the effectiveness and efficiency of systems.

Recommendation 15: Designated cameras should be used for each individual lane (page 134).

Recommendation 16: Where feasible, both plate and scene cameras should be used (page 134).

Recommendation 17: Whenever feasible, both forward facing and rearward facing cameras should be used to ensure all vehicles (including motorcycles) can be monitored by the system. If not feasible, the decision should be based on the jurisdictional requirements regarding the vehicles targeted by the system (page 134).

Recommendation 18: Digital cameras should be used, with the specific resolution of the cameras balancing requirements of the clarity of images for evidentiary purposes with system capabilities (page 135).

Recommendation 19: Monochrome cameras and infrared flash should be used (page 135).

Recommendation 20: Camera activation systems should be rigorously tested prior to use to ensure appropriate degrees of accuracy in detecting vehicles passing the camera site. Consideration must also be given regarding how invasive the approach to camera activation is, in terms of disturbance to the road environment (page 135).

Recommendation 21: Decisions regarding the approach to camera housing/mounting should consider the scope of weather conditions experienced and anticipated vandalism in the jurisdiction (page 135).

Recommendation 22a: Where feasible, overhead mounting should be used. When side-mounted poles are used: poles should be located such that roadside clutter and potential hazards are reduced; infrastructure (e.g., guardrails) should also be installed to protect motorists; and, cameras should be installed at an appropriate height off the ground to minimise loss in capture rates (page 135).

Recommendation 22b: Future research should seek to quantify the impact of camera mounting approach (overhead versus side-mounted) on capture rates (page 136).

Recommendation 22c: The development and trial of roadside cantilevers with arms that extend over the traffic lanes should be explored (page 136).

Recommendation 23: Installation of a point-to-point speed enforcement system should consider maintenance requirements, such that it is ensured that system maintenance results in minimal, if any, disruptions to traffic flow at the camera site (page 136).

Recommendation 24: Where feasible, ANPR/OCR processing should be conducted at the location of the camera site to minimise the amount of data that is required to be transmitted through the communication network (page 136).

Recommendation 25: ANPR/OCR software should be rigorously tested prior to use to ensure appropriate degrees of accuracy regarding both plate recognition (e.g., detecting a vehicle's number plate in the captured image) and plate reading accuracy (e.g., degree to which the correct number/letter sequence is identified and the consistency or errors across images from various points in the system) (page 136).

Recommendation 26: The amount of information captured by a system should be as extensive as feasibly possible and include, at a minimum: images from at least two camera sites; average vehicle speed; speed limit (which might include enforcement tolerance); date and time of infringement; and location of camera sites (page 137).

Recommendation 27: Appropriate security protocols should be developed to prevent unauthorised access to data and protect the transmission of data (page 137).

Recommendation 28: All images and details associated with infringements detected by point-to-point enforcement systems should be manually verified during the back-office process (page 137).

Legislative and evidentiary recommendations (pages 137-138)

Recommendation 29a: Legislation of point-to-point systems should cover, at a minimum: prescribed device; prescribed process; surveyed shortest practicable distance; synchronisation of the time clocks; definition of the data (e.g., formula used to calculate average speed); and, measurement of average speed as evidence of actual speed (page 137).

Recommendation 29b: Shortest practicable distance should be: assessed by an independent and certified surveyor using measurement methods that are traceable to national standards of distance measurement; resurveyed following any changes to the road alignment or associated infrastructure within the enforcement corridor that may affect this distance (page 137).

Recommendation 29c: Clocks associated with point-to-point speed enforcement systems should be: synchronised with a single common time source; include a secondary reference system; be synchronised regularly, with a log of drift times recorded; use measurements that are traceable to national standards of time measurement; be regularly tested and certified; and, include safeguards to ensure the accuracy of clock synchronisation (page 138).

Recommendation 30: Maintenance schedules, calibration/testing and recertification should be conducted at least annually to ensure system accuracy and support the integrity of prosecutions (page 138).

Public education recommendations (page 139)

Recommendation 31a: Public education should increase awareness among the motoring public regarding the rationale for point-to-point speed enforcement systems, in order to enhance the general deterrent effect of the technology. Other issues addressed might include a basic overview of how the approach operates and the extent of operations (page 139).

Recommendation 31b: Public education should involve the availability of sufficient information regarding the point-to-point system on the websites of relevant stakeholders. Where feasible, other common media outlets (e.g., newspapers, radio and television) should also be utilised to educate the driving public about point-to-point speed enforcement systems (page 139).

Evaluation recommendations (page 139-140)

Recommendation 32a: Point-to-point speed enforcement systems, whether implemented in trial or fully enforceable form, should be evaluated (page 139).

Recommendation 32b: Evaluations should include outcome, process, driver acceptance and cost-benefit evaluations and involve rigorous methodologies (e.g., matched control sites, statistical significance testing, control for confounding factors, sufficient baseline and follow-up data periods) (page 139).

Recommendation 32c: The cost of conducting evaluations should be factored into project development costs (page 139).

Privacy recommendations (pages 140-141)

Recommendation 33: Jurisdictions operating point-to-point speed enforcement systems should conduct Privacy Impact Assessments (PIA) to assess the privacy impacts of their systems. This assessment should form part of a Privacy Management Plan that includes privacy protections and complaint handling mechanisms for point-to-point speed enforcement systems and is reviewed regularly to ensure appropriate use of collected data (page 140).

Recommendation 34: The prescribed functions of the point-to-point system should be clearly identified. Any aspirations for extending the functionality of the system should only occur if there is no negative impact on the primary function of the system to monitor average vehicle speeds (page 141).

Additional suggestions

In addition to the recommendations for better practice outlined above, a number of suggestions are also made. These reflect instances where recommendations may be unnecessarily restrictive.

Firstly, it is suggested that jurisdictional government organisations should primarily maintain responsibility for the operation and management of point-to-point speed enforcement systems. This suggestion acknowledges that such an approach may assist in facilitating greater transparency and integrity in the systems and reduce motorist suggestions that the enforcement method is primarily associated with revenue-raising. This is perceived to be particularly important in relation to the administration of infringement notices. Public perceptions and attitudes toward the approach are argued to be important given that the approach is relatively new and that the motoring public may have difficulty understanding how the technology operates.

Secondly, consideration should be given to wholly or partly hypothecating the revenue from point-to-point speed enforcement systems into road safety and/or other public health projects and initiatives. This is currently the case with other speed camera revenue in Queensland and partly in Western Australia (now two thirds effective from 1 July 2011, increasing to 100% from 1 July 2012). Such a practice, particularly if well communicated to the public, would be likely to further appease criticisms that speed camera operations are performed primarily for the purpose of increasing consolidated revenue. Such a suggestion is also relevant to the revenue generated from other speed enforcement approaches.

Thirdly, national licence and registration databases (such as NEVDIS) must ensure adequate ability for cross-jurisdictional cooperation, including the sharing of information to improve prosecutability of interstate offenders.

1. INTRODUCTION

Point-to-point enforcement is a relatively new technological approach to traffic enforcement increasing in popularity in a number of highly motorised countries. While the approach is most commonly implemented to enforce speed limits, similar technology has also been applied for the purposes of monitoring a range of other traffic offences, including lane and toll enforcement, access regulation, tracking of stolen vehicles, identification of unlicensed motorists, and even counterterrorism. This report will focus primarily on the implementation of point-to-point camera enforcement systems for the purpose of monitoring compliance with posted speed limits.

Various terminologies are used to refer to point-to-point speed enforcement, largely dependent on the jurisdiction in question. In the United Kingdom, the approach is commonly referred to as average speed enforcement, while other European nations commonly refer to the technology as section or trajectory control or more specifically by the system in place (e.g., Tutor – Italy; SPECS – United Kingdom). In addition, the technology has also been referred to as time-over-distance, distance-over-time or speed-over-distance enforcement, reflecting the calculation used to measure average speed. For the purposes of clarity, this report will refer to the technology as point-to-point speed enforcement, given that this terminology is most common in the Australian and New Zealand context.

This report will review the international literature regarding point-to-point speed enforcement, including an examination of the extent of the use of the technology throughout the world and a critical appraisal of empirical studies evaluating the effectiveness of the approach. In addition, the variation in technological and operational characteristics and legislative requirements associated with the technology across different jurisdictions is investigated and reported.

Based on this information, principles for better practice regarding the use of point-to-point speed camera enforcement are outlined, taking into account the context of overall speed management in each jurisdiction. These recommendations for better practice will include general principles for effective use of the technology, as well as contextualised principles that take into account the various situations in which point-to-point is regularly implemented (e.g., focusing on various vehicle types; short versus long distances; temporary versus permanent; open roads versus arterial/local roads).

1.1 Structure of the report

In Section 1 of this report, the scope of the speeding problem is outlined to highlight the need for developing innovative approaches to speed management, and in particular speed enforcement. Section 2 provides a detailed overview of the methodology used to collect and analyse data used in the project.

In Section 3, a detailed review of the existing empirical data regarding the effectiveness of point-to-point speed enforcement is provided. The impact of the technology on a number of road safety and public health outcomes is analysed, including crash rates, vehicle speeds, traffic flow, congestion, emissions and noise. Driver perceptions of the approach are also reviewed, as well as cost-effectiveness. Where possible, point-to-point speed enforcement is directly compared to other approaches to speed enforcement, particularly other automated approaches. Section 4 provides a technological overview of point-to-point speed enforcement systems and the specific components of such systems.

Section 5 reports on the findings of national and international stakeholder consultations and a national working group. From these finding a comprehensive overview of the extent of the use of point-to-point speed enforcement systems is provided, as well as overviews of the technological, operational and legislative characteristics associated with point-to-point use in each jurisdiction. In addition, broader issues associated with speed management, road safety, public education and evaluation within the various jurisdictions are also discussed.

Finally, Section 6 presents the recommendations for better practice for the implementation of point-to-point speed enforcement in Australia and New Zealand. These recommendations are based on the findings of the stakeholder consultation phase of the research, as well as additional information from the literature review.

1.2 Contributing role of speed to road trauma

Trauma resulting from traffic crashes is a significant problem worldwide and is associated with substantial economic and social costs. Each year more than a million people are killed, and an additional 50 million are seriously injured, on roads throughout the world (Peden et al., 2004; Richter, Berman, Friedman, & Ben-David, 2006). It has been estimated that traffic crashes have a global cost of approximately $US518 billion each year (Richter, et al., 2006). Indeed, costs associated with traffic crashes in Australia have been estimated to be approximately $AU17 billion a year (Connelly & Supangan, 2006). These costs predominately involve human costs, such as medical treatment, hospitalisation and loss of productivity, with costs associated with serious injury crashes representing 61% of all costs, compared to less than 18% associated with fatal crashes (Connelly & Supangan, 2006).

There is a growing body of evidence confirming a positive relationship between increased vehicle speeds and increased crash risk and injury severity, with speed regularly cited as a major contributing factor in traffic crashes (Aarts & van Schagen, 2006; Fildes, Rumbold, & Leening, 1991; Kloeden, McLean, & Glonek, 2002; Kloeden, McLean, Moore, & Ponte, 1997a; Lynam & Hummel, 2002). Consequently, a number of speed reduction countermeasures have been developed and evaluated in terms of their ability to reduce speed-related fatalities and injuries. Such countermeasures generally fall into two categories, being the management of vehicle speeds and enforcement of posted speed limits. This includes initiatives such as speed enforcement, road engineering (e.g., speed calming road designs), lowering speed limits and the utilisation of intelligent transportation systems (Richter, et al., 2006).

Despite the increases in both the range and intensity of approaches to speed enforcement, a number of recent Australian studies have provided evidence to suggest that speeding remains relatively commonplace, with the majority of motorists choosing speeds within 10 km/h over the speed limit (Glendon, 2007; Glendon & Sutton, 2005; Roads and Traffic Authority, 2000; 2009; Walker, Murdoch, Bryant, Barnes, & Johnson, 2009). These findings concur with studies using self-report measures of speeding, which have suggested a general social acceptability of speeding behaviour, particularly when it is perceived to not be excessive (Fleiter & Watson, 2006; Hatfield & Job, 2006).

Moreover, drivers are increasingly adapting their driving behaviour, including their speeding behaviour, in association with traditional speed enforcement methods. Such behavioural modifications, which include but are not limited to site-learning and modifying behaviour only in the immediate vicinity of speed enforcement, serve to aid punishment avoidance through non-detection. A number of researchers have highlighted the influence of punishment avoidance on continued offending. Specifically, it has been suggested that punishment avoidance may do more to reinforce speeding behaviour than punishment does to discourage it (Freeman & Watson, 2006; Stafford & Warr, 1993). Thus, there is a need to develop innovative approaches to speed enforcement that enable more widespread enforcement, and hence reduce opportunities for punishment avoidance.

The low perceived risk associated with 'low-level' speeding is often argued to be a justification for speeding behaviour and to represent the minimal need for enforcing 'minor' speed infractions. However, exceeding the speed limit, even by small amounts, has been found to be associated with substantial increases in crash risk and injury severity (Kloeden, McLean, & Glonek, 2002) and even small reductions in vehicle speeds can produce significant reductions in crash outcomes (Nilsson, 2004). Therefore, reducing 'low-level' speeding represents an important road safety goal and, from a policy perspective, it is critical to continually demonstrate to a sceptical public and media that speed enforcement initiatives are about achieving improved road safety, rather than revenue-raising for perceived 'minor' and 'inconsequential' breaches of traffic laws. This issue was highlighted as an important challenge in Australia's recently released National Road Safety Strategy 2011-2020 (Australian Transport Council, 2011).

Finally, in addition to the heightened risks associated with increased vehicle speeds, speed variation between vehicles also increases the risk of crash involvement (Cirillo, 1968; Solomon, 1964; Transportation Research Board, 1998). Specifically, increased speed variation disrupts homogenised traffic flow, reduces headway distances between vehicles and increases the likelihood of conflict situations caused by human errors of judgement.

2. PROJECT OBJECTIVES & METHODOLOGY

This project involved a number of objectives including:

- Review the international empirical literature (including grey research) evaluating the effectiveness of point-to-point speed enforcement on key road safety and public health outcomes (e.g., crashes, speeding behaviour, emissions/noise, congestion, cost-effectiveness)
- Provide a technological overview of point-to-point speed camera enforcement systems used throughout the world
- Outline the extent of the use of point-to-point speed enforcement throughout the world and identify the between-jurisdictional differences in technological, operational and legislative characteristics associated with the implementation of the approach
- Provide recommendations for better practice regarding the implementation of point-to-point speed camera systems in Australia and New Zealand.
- These objectives were achieved through a series of research activities, including:
- A literature review with international scope
- Extensive consultations with key road safety stakeholders in Australia and New Zealand, as well as international jurisdictions
- A one-day working group with key Australian and New Zealand stakeholders.

The following sections outline, in greater detail, the specific methodology associated with each of these research actions.

2.1 Literature review

Relevant evaluation studies were identified through systematic searches of key road safety online databases using an iterative search strategy with key search terms. In addition, the reference lists of all retrieved studies were searched and cross referenced for relevant studies. The search terms used and databases searched can be found in Appendix A. Extensive internet searches using Google and Google scholar were also conducted. In addition, websites for key road safety organisations, police and transport authorities and speed camera technology manufacturers were also searched for relevant studies and links. Finally, during the stakeholder consultation phase, representatives from the organisations contacted were encouraged to identify relevant research (conducted by their organisation or otherwise).

It should be noted that, prior to this report, the authors had previously prepared a literature review relating to point-to-point speed enforcement for the Department of Transport and Main Roads (Queensland). The literature review of the current report builds on this previous research. Given the proportion of grey literature regarding the technology, the previous project also involved extensive contact with national and international organisations in an effort to uncover relevant research. Such a process undoubtedly aided the identification of appropriate stakeholders to contact in the second phase of the current project. This consultation process is discussed below.

2.2 Stakeholder consultations

Prior to conducting the stakeholder consultation phase, CARRS-Q obtained research ethics approval from the Queensland University of Technology (QUT) University Human Research Ethics Committee (UHREC – 1000001067). In addition, an interview schedule was developed by the project team prior to the commencement of stakeholder interviews. This document outlined the specific issues to be addressed during the stakeholder consultation phase and ensured accurate and comprehensive data collection across each jurisdiction, as well as consistency across each interview. The document is provided as Appendix B.

2.2.1 Data collection

During the literature review phase of the project, a comprehensive list of countries that had implemented point-to-point systems for the purpose of speed management (either in trial or full form) was developed. Key road safety stakeholders in each of the relevant jurisdictions were then identified through web searches and existing contacts of the research team. The stakeholders of interest included the following organisations from each of the jurisdictions:

- Police agencies
- Transport/highway authorities
- Motoring groups (both representatives of all motorists and of specific groups, such as motorcyclists/truck drivers)
- Road safety research centres
- Manufacturers of speed detection equipment
- Measurement/privacy departments.

Where state/county level jurisdictional differences were identified (e.g., as in Australia and the United Kingdom), attempts were made to contact stakeholders from each state/county. This was particularly important in Australia given the context of the project. In the United Kingdom, this practice proved problematic given the large number of counties.

All but two of the Australian and New Zealand organisations contacted during the consultation phase of the project provided some type of response. For those expressing an inability to participate in the research, the predominant justification for non-involvement was the existence of a more appropriate organisation within the jurisdiction to field such enquiries. At least one relevant stakeholder was consulted in all Australian and New Zealand jurisdictions.

As would be expected, there was a slightly poorer response rate for initial and follow-up contacts made to international stakeholders. Language barriers appeared to heavily influence response rates, with only two agencies failing to respond from predominantly English speaking countries. Where possible emails were translated and sent to organisations both in English and the more predominant language of the country (e.g., France and Italy). Encouragingly, an informative response was received from an organisation from each jurisdiction of interest except Northern Ireland, Sweden, Norway and the Czech Republic.

Initial contact with relevant stakeholders was made via email and/or telephone[1]. During this process, the purpose of the project was explained and a formal invitation for representatives from the organisation to participate was provided. Once the most appropriate representative/s from each organisation was identified, stakeholder interviews were organised to be conducted utilising the most interactive medium feasibly available. In a

[1] Each organisation was contacted a minimum of four times via the most appropriate medium. When this failed to produce a response, all feasible attempts to identify other appropriate routes for communication were also exhausted.

number of instances, stakeholder interviews involved representatives from a number of organisations within the same jurisdiction at the same time, similar to a small focus group.

Face-to-face meetings were conducted for the majority of organisations located in Queensland, New South Wales and Victoria. For all other Australian, New Zealand and international jurisdictions, stakeholder interviews were conducted via teleconferences or electronically through the distribution of questionnaires through email.

A number of factors contributed to a majority of organisations, particularly those located overseas, choosing to participate through email correspondence. Firstly, due to time differences between Australia and the United Kingdom and Europe, organising a suitable teleconferencing time proved problematic. In addition, a number of agencies cited concerns regarding the privacy of information and suggested that electronic mediums provided a better safeguard against accidental disclosure of sensitive information. Nonetheless, a number of teleconferences were conducted with international agencies.

Stakeholder interviews took between 30-90 minutes. The variation depended largely on the number of stakeholders involved and the extent of the implementation of point-to-point in the jurisdiction. In all but one interview, discussions were audio recorded for transcribing purposes and use in the qualitative analysis.

2.2.2 Interview schedule/questionnaire

After initial contact had been established and stakeholders had expressed their willingness to participate in the consultation phase of the project, each organisation was provided with a questionnaire and/or interview schedule (see Appendix B).

Representatives from each organisation were encouraged to complete questions pertaining to the extent of point-to-point implementation and technological characteristics of the systems used via a questionnaire emailed to them. It was determined that this process would facilitate more accurate responding compared to addressing such issues in a teleconference or face-to-face meeting scenario. In addition, while relatively quick to respond to, there were a large number of items investigating the technological characteristics of the systems. Thus, addressing these issues in questionnaire form allowed for more efficient use of time during teleconferences/face-to-face meetings to address broader level issues.

Given the difficulties associated with teleconferencing with international organisations, such as time differences and conflicting schedules, many international agencies also chose to address the operational, legislative and other broader level issues via a questionnaire format. In all instances, agencies where provided with an identical list of questions, with the exception of some contextually relevant changes to wording (e.g., referring to the technology as point-to-point for Australian organisations, average speed enforcement for United Kingdom organisations and section control for other European organisations).

2.2.3 Data analysis

A content analysis of the qualitative responses from the stakeholder interviews was conducted, using the transcripts provided from the audio recordings and/or the written responses to questionnaires returned via email. The analysis identified the primary themes covered in the consultation process, including the extent of use of point-to-point systems, technological and operational characteristics of the systems, legislative particulars associated with use of the technology and broader issues including barriers to effective implementation, public education, evaluation of the systems and where point-to-point fits within the overall speed management strategy adopted in different jurisdictions.

2.3 Working group

The final phase of the research process involved the facilitation of a working group involving key Australian and New Zealand stakeholders, including representatives from the Police and/or transport authorities in each jurisdiction. The working group involved a one-day meeting conducted in May 2011 in Sydney, coinciding with the Road Safety Regulator's Workshop hosted by the Roads and Maritime Services (RMS)[2]. The proceedings of the program involved a presentation by the research team outlining the key findings from the draft report, including the literature review and stakeholder interviews, followed by group discussion on many of the key aspects presented and the seeking of feedback regarding proposed recommendations towards better practice.

A content analysis of the feedback from the working group discussions was conducted to identify technological, operational and legislative characteristics of effective systems not identified during the literature review or stakeholder consultation phases of the project. These findings then supplemented information collected from previous phases of the project to further identify better practice principles regarding the implementation and operation of point-to-point enforcement systems in Australia and New Zealand.

[2] At the time of project inception, the RMS went by the former title of the Roads and Traffic Authority (RTA).

3. EFFECTS OF POINT-TO-POINT SPEED ENFORCEMENT

To date, there have been no formal evaluations of any of the implementations or trials of point-to-point speed enforcement in Australia. Nonetheless, stakeholders from Victoria and New South Wales highlighted that producing empirical evaluations of the point-to-point systems operating in their jurisdictions is a priority. At the time this project was conducted, the majority of empirical research had originated from the United Kingdom, with a number of evaluation studies also conducted in other European countries, namely the Netherlands, Austria, Italy and France.

The following sections review the literature assessing the impact of point-to-point speed enforcement on vehicle speed, traffic crashes, vehicle emissions and noise, as well as traffic flow. In addition, findings from driver surveys regarding motorist attitudes toward point-to-point speed enforcement are also discussed. Finally, an overview is provided regarding the reported cost-effectiveness of the approach.

From the outset, it is important to acknowledge the relatively poor levels of scientific rigour associated with the current body of literature evaluating point-to-point speed enforcement. Indeed, this low standard of rigour negated the opportunity for a meaningful assessment of study quality from which to further quantify the findings. Specifically, comparison/control sites are not used, confounding factors are rarely controlled for (e.g., exposure, regression-to-the-mean) and statistical significance testing is typically not performed. Moreover, many studies represent non-independent research conducted by equipment manufacturers or the organisations responsible for the operation and management of the systems. Thus, the evidence presented in this section of the report should be considered in light of these methodological shortcomings. That said the consistency of the positive effects of the approach is encouraging.

3.1 Effects on vehicle speed

Table 3.1 highlights the main findings of research from around the world, evaluating the impact of point-to-point speed enforcement on vehicle speeds. This research suggests that there is considerable evidence suggesting a positive influence of the approach on a number of speed measures, including:

- Average/mean speeds
- 85th percentile speeds
- The proportion of speeding vehicles
- Speed variability.

Previous research has highlighted the road safety benefits associated with reducing absolute vehicle speeds (Aarts & van Schagen, 2006; Kloeden, McLean, Moore, & Ponte, 1997). Evaluations of point-to-point systems have typically reported substantial reductions in mean and 85th percentile speeds associated with the introduction of the technology. Moreover, average (and often even 85th percentile) speeds are reduced to at or below the posted speed limit. Such impacts have been reported in association with both permanent and temporary systems employed in various countries throughout the world.

Following on from these findings, it is not surprising that numerous studies have shown that point-to-point speed enforcement is typically associated with exceptional rates of compliance with posted speed limits. Indeed, offence rates are typically reported to be less than 1%, even when daily traffic volume is high, and the proportion of vehicles exceeding the speed limits is often found to be drastically reduced (upwards of a 90% reduction). Moreover, point-to-point has been argued as a particularly effective approach in reducing excessive speeding behaviour (Gains et al., 2005; Schwab, 2006; Speed Check Services, 2008a; Transport Scotland, 2009). In Australia, Cameron (2008) commented on rates of compliance associated with point-to-point use on the Hume Highway in Victoria, noting that approximately 1 000 vehicles were processed daily for speeding offences (from an estimated daily traffic volume of up to 100 000 vehicles), representing an offence rate of approximately 1-2%.

Speed variability between vehicles has also been shown to increase the likelihood of crash involvement (Cirillo, 1968; Solomon, 1964; Transportation Research Board, 1998). Given the high degree of compliance associated with point-to-point speed enforcement, the approach is typically associated with reduced speed variations given that the majority of motorists choose vehicle speeds close to the speed limit. Such changes in vehicle speed choice typically produce more homogenised traffic flows, improved traffic density and reduced journey travel times (see Section 3.3). Indeed, reductions in speed variability and subsequent traffic flow improvements have been found in association with numerous installations of point-to-point speed enforcement systems, including both permanent (Charlesworth, 2008; Thornton, 2010) and temporary systems (Speed Check Services, 2006, 2007b, 2008a).

For example, in a comparison of three sections of road in the United Kingdom, speed variations were reported to be lowest when point-to-point enforcement was in place (Thornton, 2010). Specifically, on a 70mph section of motorway not enforced by point-to-point, 60% of vehicles were observed travelling within a 15mph range. Comparatively, 60% of vehicles were observed within a 5mph range for a 70mph section of motorway enforced by point-to-point and a 3mph range for a 50mph section of motorway temporarily enforced with point-to-point during roadworks. Indeed, the typical speed profile for roads with point-to-point enforcement in the United Kingdom, suggests that most vehicles travel within 3mph of the posted speed limit (Charlesworth, 2008).

However, as is evident from Table 3.1, a large proportion of the available research stems from non-independent evaluations. Such evaluations are conducted by system manufacturers and providers, or by the organisations responsible for the operation and management of the systems. In addition, few studies employ rigorous scientific methodologies.

Table 3.1: Summary of findings of effect of point-to-point speed enforcement on vehicle speeds.

Source	Location/s	Details of system/s[1]	Main findings
Australia			
Cameron (2008)	Victoria	Hume Highway (100-110 km/h); permanent	Average daily offence rate 1-2% (estimated daily traffic volume up to 100 000 vehicles)
England			
Speed Check Services (2010)	Nottingham	A610 (30mph); A6514 (40mph); both permanent	Comparing 3 yrs prior to 3 yrs post installation; 85th percentile speeds reduced from 44mph to 40mph on the A6514 and 39mph to 30mph on the A610; average speed reduced by 9mph (to 24mph) on the A610
Speed Check Services (2010)	Northampton	A43 (50mph); permanent	Comparing 3 yrs prior to 3 yrs post installation; 85th percentile speeds reduced from 58mph to 45mph
Speed Check Services (2010)	South Yorkshire	A616 (40mph); permanent	Comparing 3yrs prior to 3yrs post installation: proportion of vehicles exceeding speed limit reduced from 45% to 15% (eastbound) and from 20% to 4% (westbound) – no explanation for difference in compliance dependent on direction
Stakeholder consultation provided data (2011)	Nottingham & Northampton	11 sites across Nottingham and 2 in Northampton	Across the sites: 85th percentile speeds reduced by average of 14.4% (range 30.3% decrease to 2.7% increase) – only one site increased; average speeds reduced by average of 12.5% (range 30% decrease to 4.8% increase) -2 sites increase, one remained unchanged; proportion of vehicles above speed limit ranged from 0.05% to 7% - only 2 sites above 0.5%; less than 0.025% of vehicles exceeding speed limit by more than 15mph at all sites
Barker (2005)	Nottingham & Northampton	Various sites	Reported on findings from a four-year evaluation: average offence rates on Nottingham Ring Road were 0.02%; daily offence rate reduced from 13 to 8 in Northampton
Palmer (1999)	Kent	M20 & M1 (speed limit unknown); trial sites	Speed offences reduced by approximately 30% even though no infringements were formally issued during the trial
Speed Check Services (2010)	Hertfordshire	M1 Jn 6a-10 (50mph reduced limit); temporary during roadworks	Comparing 3yrs pre to 2yrs post installation: 85th percentile speed 50.1mph; average speed 47.9mph; 15.8% of vehicles exceeding speed limit; only a few hundred tickets issued per week (despite considerable traffic flow – up to 14 000 vehicles an hour during peak times)
Speed Check Services (2006); Charlesworth (2008)	Leicestershire	M1 Jn 20-21 (40mph reduced limit); temporary during roadworks	85th percentile speed 39.5mph; average speed 36mph; proportion of vehicles exceeding speed limit 10.6%; proportion of vehicles exceeding ACPO enforcement threshold 1.3%; speed deviation 1mph – no mention of baseline/pre-implementation data; average of 250 speeding infringements per week (estimated traffic volume of over 700 000 vehicles per week)
Speed Check Services (2008b); Speed Check Services (2010)	Thames Valley	M4 Jn 10-12 (50mph reduced limit); temporary during roadworks	85th percentile speed 49.2mph (eastbound) and 48.9mph (westbound); average speed 46.6mph (eastbound) and 46.1mph (westbound); proportion of vehicles exceeding speed limit 9.4% - no mention of baseline/pre-implementation data; average 9.2 offences per day (approx. 90 000 daily traffic volume) – 0.01% offence rate

Source	Location/s	Details of system/s1	Main findings
England (cont'd)			
Stephens (2007)	Exeter	M5 Jn 29-30 (50mph reduced limit); temporary during roadworks	Reduction in average speeds (to below 50mph) maintained throughout period of the roadworks; reduction in 95th percentile speeds to less than 55mph; reduction in difference between 95th percentile and average speeds from 16mph to 6mph; average 45 offences per week (approx. 210 000 weekly traffic volume)
Speed Check Services (2007b)	Staffordshire	M6 Jn 12-13 (40mph reduced limit); temporary during roadworks	85th percentile speed 38mph; average speed 36mph; proportion of vehicles exceeding speed limit 3.5%
Highways Agency & Atkins Consultants (2009); Collins (2010)	Cambridge	A14 (NSL[2]); permanent	At the 6 camera sites average speeds were reduced at 4 sites, but increased at 2 sites (1mph and 5mph). 85th percentile speeds were reduced at 4 sites, unchanged at 1 site and increased by 3mph at 1 site. In first 3 years of operation only 1 077 infringements issued (0.0002% of vehicles travelling on section). Overall speed variation reduced with only 0.1% exceeding the 70mph limit.
Scotland			
Speed Check Services (2010); A77 Safety Group (2007, 2008); Scottish Safety Camera Programme (2006); Townsend (2006)	Strathclyde	A77 (NSL[2]); permanent	In first 3 yrs of implementation: number of vehicles exceeding the speed limit reduced by approximately 90% on dual carriageway sections and by 80% on single carriageway sections; only 1 027 infringements issued (320 infringement in first two years despite estimated traffic flow of 24 million vehicles during same period) - 707 infringements issued during third year following the introduction of a 50mph section within the enforced route (March 2008), despite prominent signage, VMS and extensive publicity campaign
Collins & McConnell (2008)	Glasgow	M8 Jn 28 (speed limit unknown); temporary during roadworks	Offence rates only 0.2%; average daily infringements reduced from more than 100 to less than 10
Netherlands			
Stoelhorst (2008); Stefan (2005); KfV (2007); RWS (2003)	Rotterdam	A13 (80 km/h – reduced from 100 km/h); permanent	Free-flow average speeds reduced by 15-20 km/h; average speed reduced from 100 km/h to 80 km/h for passenger vehicles and 90 km/h to 80 km/h for heavy vehicles; speed variation and 85th percentile speeds also reduced (exact amounts not detailed); offence rates reduced from 4.6% to 0.6% (weekday) and 0.9% (weekend) - estimated traffic volume of 124 000 vehicles per day
Malenstein (1997)	Amsterdam	A2 (120 km/h); 3 trial sites	Average vehicle speeds reduced from 115 km/h to 106 km/h; proportion of vehicles exceeding the speed limit reduced by 90%
Austria			
Stefan (2006)	Vienna	A22 Tunnel (80 km/h cars & 60 km/h HGV); permanent	Passenger vehicle speeds reduced by 10 km/h during daytime conditions and 20 km/h during night-time conditions; heavy vehicle speeds reduced by 15 km/h during daytime conditions and 20 km/h during night-time conditions; approximately 40 000 infringements in first year of operation (estimated traffic volume of 29 million vehicles during same period) representing an offending vehicle in every 725 vehicles

Source	Location/s	Details of system/s1	Main findings
Italy			
ASPI (2009); Galata (2007)	Italy	Review of all sites	Significant reduction in average speeds of 15% during first 12 months of operation (down by 16 km/h); maximum speeds reduced by 23 km/h (25%). More recent results: mean speeds further reduced by 9.1 km/h; reductions larger during free-flow conditions compared to peak-hour
Cascetta & Punzo (2011)	Naples	A56 (80 km/h); permanent	Comparing 1 week pre with 1 week post installation data: mean speed reduced from 80.8 km/h to 71.7 km/h; proportion of speeding vehicles reduced from 51.6% to 17.4%; proportion of vehicles excessively speeding (40 km/h + over) reduced from 1.2% to 0.1%; speed variance reduced from 18.1 km/h to 12.1 km/h; reductions greater during free-flow conditions compared to peak-hour; findings consistent across the majority of A56 sections (some sections with irregular road alignment showed smaller reductions or increased speed variations)
France			
Speed Check Services (2004)	France	Various sites (90 km/h); advisory[3] (e.g., not enforceable) mobile/ temporary system	System evaluated under three conditions[4]: vehicles detected exceeding 110 km/h (in 90 km/h zone) = Stage 1 (76%), Stage 2 (39%), Stage 3 (24%)
Schwab (2006)	Rhone Valley	A7 (90 km/h & 110 km/h phases); temporary during roadworks	During 90 km/h phase: 80% driving at less than 100 km/h; during the 110 km/h phase: 90% of motorists driving at 115 km/h or less; overall: 68% of speeding motorists less than 10 km/h over the speed limit
Czech Republic			
KfV (2007)	Czech Republic	Unknown	Proportion of vehicles exceeding the speed limit reduced by 70% after first year of implementation

1. For a more detailed description of the system, see the relevant subsection of Section 5.
2. National Speed Limit. Differs by vehicle and road type. For a full outline see http://www.direct.gov.uk/en/TravelAndTransport/Roadsafetyadvice/DG_178867.
3. VMS signs displayed warning messages to motorists detected exceeding the speed limit – signs included captured speed, number plate and 'Warning – Slow Down' message.
4. Stage 1 = no speed advisory equipment in place, Stage 2 = VMS displaying blank messages, Stage 3 = system fully operational (displaying messages as per note 3).

3.2 Crash fatality and injury reduction[3]

Speed Check Services has conducted a number of evaluation studies on point-to-point systems throughout the United Kingdom. As can be seen from Table 3.2, many of these studies reported reductions in all crash types, particularly fatal and serious injury crashes. Similar results were found from evaluations conducted in Italy, Austria and the Netherlands.

Speed Check Services (now referred to as Vysionics) has conducted a number of evaluation studies on the effects of point-to-point systems on road crashes and related injuries throughout the United Kingdom. As can be seen from the data presented in Table 3.2, these evaluations involve consideration of varying lengths of time for pre- and post-implementation, ranging from two to eight years. Taking this range of time differences into consideration, the evaluation results generally indicate a decreasing trend in KSI (killed or serious injury) crashes after the installation of point-to-point speed enforcement in the order of between 33-85%. Reductions in minor injury crashes were also noted. However, statistical significance testing, the control of confounding factors (including regression-to-the-mean) and the use of control/comparison areas, were absent from all these evaluations.

In addition to the studies conducted by Speed Check Services, a number of other studies and data provided during stakeholder consultations also suggested that point-to-point speed enforcement was associated with positive road safety benefits in the United Kingdom.

Moreover, similar levels of crash reductions have been reported in association with evaluations conducted in Italy, Austria and the Netherlands. It is noted that in the Netherlands, the implementation of the point-to-point system coincided with the introduction of a reduced speed limit (from 100 km/h to 80 km/h) and that therefore, the proportion of the observed reduction attributable to point-to-point enforcement could not be reliably determined. Nonetheless, the downward trend in crashes and associate deaths and injuries from the evaluations in these three countries is also encouraging.

[3] Given the differences in section lengths and in pre and post evaluation periods it is more practical to consider crash reduction data in terms of percentages rather than frequencies.

Table 3.2: Summary of findings of effect of point-to-point speed enforcement on traffic crashes.

Source	Location/s	Details of system/s[1]	Main findings
England			
Speed Check Services (2010)	Nottingham	A610 (30mph); A6514 (40mph); both permanent	Comparing 3yrs prior to 7-8yrs post installation (adjusted): across all sites KSI crashes reduced by 65%; KSI crashes reduced by 53% on the A6514 and 45% on the A610; PIC crashes reduced by 46% on the A6514 and 60% on the A610; fatalities reduced from 6 to 1 on the A6514 and from 3 to 0 on the A610
Speed Check Services (2009b)	Nottingham	A631 (30mph); B6004 (30/40mph); both permanent	Comparing 36mths prior to 28mths post installation: KSI crashes reduced from 2 to 0 on the A631 Comparing 36mths prior to 39mths post installation (adjusted): KSI crashes reduced by 72% (annual average reduced from 4.33 to 1.23) on the B6004
Speed Check Services (2009b, 2010)	Northampton	A43 (50mph); A428 (60mph); both permanent	Comparing 36mths prior to 61mths post installation (adjusted): KSI crashes reduced by 77.9% on the A43 (annual average reduced from 2.67 to 0.59) Comparing 50mths prior to 50mths post installation: KSI crashes reduced by 85.2% on the A428 (annual average reduced from 6.5 to 0.96; fatalities from 2.9 to 0.24, seriously injured from 3.6 to 0.72)
Speed Check Services (2010)	South Yorkshire	A616 (40mph); permanent	Comparing 3yrs prior to 5yrs post installation (adjusted): KSI crashes reduced by 82% (annual average reduced from 6.67 to 1.2; fatalities from 3 to 0.2, seriously injured from 3.67 to 1)
Stakeholder consultation provided data (2011)	London, Northampton, Nottingham, South Yorkshire	1 site in London, 2 in Northampton, 11 in Nottingham, 1 in South Yorkshire	Comparing 2yrs pre to 2-6yrs post installation (adjusted), across sites: KSI crashes reduced by average of 51.6% - 1 site 91.8% increase, 4 sites 1-33% reduction, 2 sites 34-66% reduction, 8 sites 67-100% reduction; all casualties reduced by average of 41.8% - 2 sites increased (3.3% & 6.2%), 3 sites 1-33% reduction, 7 sites 34-66% reduction, 3 sites 67-100% reduction; number of KSI collisions reduced on average by 64.9% - no sites increased, 2 remained unchanged; number of casualty collisions reduced on average by 73.5% - all sites decreased (range 53.8% to 85%)
Speed Check Services (2010)	Hertfordshire	M1 Jn 6a-10 (50mph reduced limit); temporary during roadworks	Comparing 3yrs pre to 2yrs post installation: Fatalities reduced from 2 to 0, serious injury crashes reduced by 64%; minor injury crashes reduced by 53%. Argued to represent an annual saving in social costs of £6.8m
Speed Check Services (2010); Speed Check Services (2009a)	Thames Valley	M4 Jn 10-12 (50mph reduced limit); temporary during roadworks	Comparing 3yrs pre to 1yr post installation: KSI crashes reduced from 7 to 0; minor injury crashes reduced from 3yr pre annual average of 20.3 to 14
Stephens (2007)	Exeter	M5 Jn 29-30 (50mph reduced limit); temporary during roadworks	During 5 month roadworks period there were no injury crashes – in similar periods for three years prior the average number of injury crashes was 2.3 – this reduction was not statistically significant
Keenan (2002)	Nottingham	M1 (speed limit unknown); trial system	Casualty crashes reduced by 36.4% in first year of implementation
Highways Agency & Atkins Consultants (2009); Collins (2010)	Cambridge	A14 (NSL[2]); permanent	Compared 5 yrs pre to 13 months post full-installation (e.g., excluding construction period): Significant reduction in rate of PIC from 70.4/year to 41.5/year; reduction in PIC/mvkm from 0.119 to 0.068 (and compared to national average of 0.169); severity index of crashes reduced from 13% to 2%; no fatalities in first 13 months of full-operation. More recent data (3 years post-implementation) shows a 65.4% reduction in serious injury crashes and a 20.2% reduction in minor injury crashes.

Source	Location/s	Details of system/s1	Main findings
Scotland			
Stakeholder consultation provided data (2011); A77 Safety Group (2007, 2008)	Strathclyde	A77 (NSL[2]); permanent	Comparing 5yrs pre to 5yrs post installation (crashes within enforced area): all crashes reduced by 25.3% (from 296 to 221); fatalities reduced by 50% (from 14 to 7); serious injury crashes reduced by 40.6% (from 64 to 38); minor injury crashes reduced by 19.3% (from 218 to 176). Reported crash reductions at earlier follow-ups after implementation: - Comparing 3yrs pre to 2yrs post: all injury crashes reduced by 20.1%, fatal crashes by 33.3%, serious injury crashes by 34.4%, minor injury crashes by 15.6%; casualties from all injury crashes reduced by 32.1%, fatalities by 53.8%, serious injuries by 48.1%, minor injuries by 27.3% - Comparing 3yrs pre to 3yrs post: average annual crash rate reduced by 19%, fatal crash rate by 46% (from 4.3 to 2.3), serious injury crash rate by 35% (from 17.3 to 11.3)
Netherlands			
KfV (2007); RWS (2003)	Rotterdam	A13 (80 km/h – reduced from 100 km/h); permanent	All crashes reduced by 47%; fatalities reduced by 25%; evidence of diffusion of benefits effect, with crashes reduced by 10% up- and downstream of the enforcement site (no information regarding specific distance) - implementation of system coincided with a reduction in the speed limit from 100 km/h to 80 km/h, thus proportion of the observed reduction attributable to point-to-point cannot be reliably determined
Austria			
Stefan (2006)	Vienna	A22 Tunnel (80 km/h cars & 60 km/h HGV); permanent	Comparing 3yrs prior to 2yrs post installation (adjusted): all injury crashes reduced by 33.3%; fatal and serious injury crashes reduced by 48.8% (no fatalities in first two years of system operation); minor injury crashes reduced by 32.2%; noted that tunnel had lower than average crash rates compared to other sections of the motorway
Italy			
ASPI (2009); Galata (2007)	Italy	Review of all sites	In first year of operation (on Tutor sections): fatalities reduced by 50.8% (compared to 6.7% reduction on all ASPI network); serious injury crashes reduced by 34.8% (compared to 11.4% reduction on all ASPI network); crash rate per million kilometres driven reduced by 22% (compared to 12.7% reduction on all ASPI network) – reductions on entire ASPI network may represent diffusion effects
Cascetta & Punzo (2011); Punzo & Cascetta (2010)	Naples	A56 (80 km/h, lowered); permanent	Comparing equivalent 8mths pre to 8mths post installation: significant reduction in injury crashes of 38.8% (from 116 to 71) and fatal crashes from 4 to 0

1. For a more detailed description of the system, see the relevant subsections in Section 5.
2. National Speed Limit. Differs by vehicle and road type. For a full outline see http://www.direct.gov.uk/en/TravelAndTransport/Roadsafetyadvice/DG_178867.

3.3 Traffic flow improvement

Previous studies have highlighted the influence of variation in vehicle speeds on crashes and traffic flow (Taylor, Lynam, & Baruya, 2000). An additional benefit associated with point-to-point speed enforcement is more homogenised traffic flow and increased traffic capacity resulting from reduced vehicle speed variability and subsequent increased headway (Collins, 2007a, 2007b; Collins & McConnell, 2008; Koy & Benz, 2009; Malenstein, 1997).

Fixed and mobile cameras have been found to be associated with a stop-start motion created by acceleration and braking close to camera sites and this has been shown to have a detrimental impact on traffic flow (Keenan, 2002; Wegman & Goldenbeld, 2006). This issue is largely negated when point-to-point enforcement is used. Indeed, traffic flow was improved on the M8 during the Junction 28 roadworks in Scotland after point-to-point enforcement was installed, reducing travel times during morning peak times from 10-15 minutes to 0-5 minutes (Collins & McConnell, 2008).

In a four-year evaluation of the Nottingham ring road implementation of point-to-point speed enforcement, Barker (2005) highlighted that motorists have reported reduced traffic congestion along the monitored stretch. Similarly, a number of other studies conducted in England, Scotland, the Netherlands and France have also provided evidence of improved traffic flow, generally as a result of reductions in the standard deviation in vehicle speed variation (Malenstein, 1997; Schwab, 2006; Speed Check Services, 2006, 2007b, 2008b, 2009a; Stefan, 2005; Stevens, 2007). However, there is some evidence to suggest that an optimal speed limit is required to achieve the traffic flow improvements associated with point-to-point enforcement. In the Netherlands, an installation of point-to-point was accompanied by a reduction in the speed limit from 100 km/h to 80 km/h. This reduction actually increased traffic congestion which also partially neutralised some of the benefits on traffic noise and emissions (Stoelhorst, 2008).

In Italy, a recent before-after study was conducted to assess the impact on traffic flow patterns of the introduction of point-to-point on a section of the A56 motorway with recurrent congestion. Results suggested that vehicle speeds, and subsequently traffic flow, was homogenised and the impact of bottlenecks were reduced, resulting in more reliable and shorter journey times (Cascetta, Punzo, & Montanino, 2011).

Reduced congestion resulting from improved traffic flow due to less speed variation equates to higher volumes of traffic being able to travel through a stretch of road before traffic flow breakdown occurs. This increases the capacity of the existing road network and improves journey time reliability without the necessity to widen the road and is noted as a significantly lower cost than schemes requiring significant infrastructure and technology investment.

Finally, point-to-point speed enforcement on the Tower Bridge in London was also reported to have reduced crashes, as well as the number of overweight heavy vehicles using the bridge (Speed Check Services, 2007a).

3.4 Impact on traffic emissions and noise

A recent study conducted in the United Kingdom compared the estimated fuel consumption and emissions[4] for vehicles on three road types differing in speed limit and enforcement regime (Thornton, 2010). Specifically, the study compared a 70mph section of motorway not

[4] For a full description of how fuel consumption and emissions data were calculated, please refer to the original study (pages 1-3).

enforced with point-to-point, a 70mph section of motorway enforced by point-to-point and a 50mph section of motorway temporarily enforced with point-to-point during roadworks. Results revealed that, compared to the unenforced section of motorway, point-to-point enforcement was estimated to improve fuel consumption for an average car by 4.87 miles per gallon (mpg) when 70mph limits were enforced and 15.92mpg when 50mph limits were enforced. Moreover, point-to-point enforcement was estimated to reduce CO_2 emissions by 850 metric tonnes per mile each year when 70mph limits were enforced and 2 214 metric tonnes per mile when 50mph limits were enforced. These estimates suggest an 11.3% reduction in fuel and emissions when 70mph limits are enforced on motorway sections and 29.5% reductions when 50mph limits are enforced. The estimates were argued to be conservative. Other estimated benefits included reductions in noise and vibrations from traffic due to reduced average speeds and speed variation (Thornton, 2010).

Also recently, a before-after study was conducted in Italy to investigate the impact on vehicle emissions and fuel consumption of a reduction in the speed limit to 80 km/h, combined with point-to-point enforcement on the A56, a three-lane urban motorway, (Cascetta & Punzo, 2011; Punzo & Cascetta, 2010). Detailed data were collated regarding individual-vehicle section speeds on several sections of the motorway during various reference periods (e.g., weekday peak hours, free-flow hours, entire week) to control for the influence of road geometry and traffic conditions. Results suggest that point-to-point produced significant reductions in fuel consumption of 387.9 tonnes per year (equating to a saving of £633 838 per year); however this finding was limited to instances in which congestion was not too heavy. Moreover, reductions in emissions were also reported, with CO reduced by 15.3% (47.6 tonnes/year), NO_x by 4.6% (2.4 tonnes/year), PM_{10} by 6.4% (117.8 kg/year) and CO_2 by 5% (1 235 tonnes/year).

In the Netherlands, a similar study was conducted to evaluate the impact of point-to-point speed enforcement combined with reduced speed limits (from 100 km/h to 80 km/h) on traffic emissions and traffic flow (Stoelhorst, 2008). The changes were enacted on sections of the A10, A12 and A20 motorways, with a primary focus to improve air quality. Two scenarios were evaluated using modelling approaches, the first to produce optimal air quality by setting the speed limit at 80 km/h at all times, and the second to produce a balance between air quality and traffic efficiency by instituting the 80 km/h limit during peak hours only. Effects were estimated for both the main and secondary road networks.

Comparing the six months prior to point-to-point implementation with the 12 months following, the traffic efficiency scenario was estimated to produce only negligible differences for either the main or secondary networks (Stoelhorst, 2008). On the other hand, the air quality scenario was estimated to reduce PM_{10} (small particles) emissions by 11.5% and NO_X emissions by 5.8% on the main network. However, the effect on emissions increased slightly when considering the entire network. Impacts on congestion were also mixed. Indeed, it appears that the increased travel times on the main network caused by the reduced speed limits led to greater traffic density on secondary networks, reducing the overall impact on traffic emissions and increasing congestion on secondary networks outside of peak hours (Stoelhorst, 2008).

Grunnan et al. (2008) also comments on a modelling study conducted in the Netherlands investigating the impact of point-to-point and a reduced speed limit (from 100 km/h to 80 km/hr) on air quality. The study involved continuous monitoring of NO_X, NO_2 and PM_{10} emissions at various locations east and west of the A13 Overschie over a two year period (one year pre and one year post point-to-point implementation). Accounting for historical, meteorological and traffic conditions collated through the use of induction loops, results revealed reductions in NO_X of 15-25% and PM_{10} of 25-34% and improvement of total air quality on the A13 Overschie, with a reduction in NO_2 of 7% and in PM_{10} of 4%.

A number of studies have suggested that due to the improvements in traffic flow outlined above, subsequent reductions in traffic noise and harmful vehicle emissions can be attributed to point-to-point speed enforcement. This finding has been observed in England, Austria and the Netherlands (Collins, 2007a, 2007b; Collins & McConnell, 2008; Speed Check Services, 2009b; Stefan, 2005, 2006; Stoelhorst, 2008).

3.5 Driver perceptions and self-reported behaviour

Finally, there have been reports of high levels of public acceptance associated with point-to-point speed enforcement. A representative telephone survey of 1,500 New South Wales motorists, stratified by gender, who drive regularly, revealed that 63% of respondents supported the use of point-to-point speed enforcement[5], with support slightly stronger among non-metropolitan motorists (Walker, Murdoch, et al., 2009). In addition, stakeholder consultations with RACQ revealed that surveys conducted by the organisation in Queensland suggested that 66% of members supported the use of point-to-point speed enforcement, particularly in rural areas[6].

In the United Kingdom, a driver survey conducted in 2007 revealed that 74% of motorists reported compliance with point-to-point enforcement systems (Charlesworth, 2008). Improved traffic flow, greater vehicle headway and increased attention were also reported in association with the approach. However, only 18% reported that the systems encouraged them to drive to the speed limit on roads not enforced by point-to-point. In addition, 56% of respondents perceived instantaneous speed enforcement to be associated with effects on vehicle speed only in the immediate vicinity of the camera.

Positive findings were reported in a survey of over 1000 motorists in France. In total, 73% of respondents reported reducing their speeds after seeing the signage accompanying the point-to-point system. Moreover, 61% believed point-to-point was a very good initiative, with 54% believing it promoted driver responsibility and 17% noting a road safety benefit. More than three-quarters of respondents (77%) reported that the operation was not restrictive and that they benefited from the operation (Schwab, 2006).

In addition, public acceptance was also reported to be high during the initial implementation of point-to-point speed enforcement in the Netherlands, given the fact that the technology measures speeding behaviour over a greater section of the road network rather than the snapshot measurement associated with fixed cameras (Malenstein, 1997). Thus, 75% of motorists reported that they perceived the approach to be fairer than other types of automated speed enforcement. Moreover, 70% of motorists reported few privacy concerns with the technology and reduced braking in the immediate vicinity of the camera site. Similar rates of support have also been reported in other driver surveys conducted in Europe, with up to 70% of motorists supportive of point-to-point speed enforcement (Kuratorium fur Verkehrssicherheit, 2007; SWOV Institute for Road Safety Research). Additionally, a British driver survey revealed that 72% of respondents support the introduction of point-to-point on 20mph roads (Crawford, 2009).

In Finland, 84% of the drivers were reported to be accepting of the technology, with only 10% reporting that they perceived the approach as unacceptable (Stakeholder Consultation).

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[5] It should be noted that at the time the survey was conducted, point-to-point speed enforcement applied only to heavy vehicles in New South Wales.
[6] At the time the research was conducted, point-to-point was not yet operational in Queensland.

Driver perceptions towards the introduction of point-to-point speed enforcement, in countries not yet employing the technology, have also been assessed. In Korea, a driver survey revealed that approximately 70% of respondents supported the introduction of point-to-point (Lee, 2007).

Overall, point-to-point technology generally enjoys a higher level of public support than other speed enforcement interventions. This is largely a function of the fact that the approach measures speed over a greater distance compared to instantaneous speed checks which may result in motorists being penalised for momentary lapses in concentration (Malenstein, 1997; Stefan, 2005; van Schagen, Wegman, & Roszbach, 2004).

3.6 Costs and benefits of point-to-point enforcement

Compared to other speed enforcement approaches, point-to-point systems are a relatively expensive enterprise. Redflex[7] note the difficulty in estimating a typical cost for point-to-point speed enforcement systems. Indeed, they highlight that costs are very dependent on site configuration (such as whether cameras will be forward or rearward facing or both), the number of lanes to be monitored (which affects the number of required cameras), whether the system will be fixed to existing gantries or mounted on the roadside, and the general location of the system. Cameron (2008), in further discussions with Redflex, highlights a number of other factors affecting system costs including traffic volume (which affects computer processing and data storage requirements) and whether sites of cameras are constructed at the same location (which saves on infrastructure costs). He suggests that the cost of a pair of camera sites could range from AUS$150 000 to as much as AUS$600 000.

A number of studies have provided information on the estimated cost of point-to-point systems located throughout the world[8], as discussed below.

- In South Australia, Department of Planning, Transport and Infrastructure (DPTI)[9] have a reported budget of $1.75 million (over a two year period) allocated for the development and implementation of infrastructure, system hardware and development of back office software10. Moreover, South Australian Police (SAPol) have been allocated an additional $500 000 for software development for the purpose of updating their systems to be capable for digital enforcement technology (Lynch, 2010)
- An early estimate given in 2003 for the cost of the Victorian system was AUS$2 million, however the final specifications changed significantly in the years preceding its full implementation in 2007 (Cameron, 2008).
- In the United Kingdom, Speed Check Services11 in 2005 reported that a fully installed point-to-point system was estimated to cost £290 000 (Cameron, 2008). The six pairs of cameras in the initial Nottingham installation were reported to cost £600 000 to install and £22 000 in annual maintenance costs, while the six pairs installed in Gloucester cost £340 000 to install and £12 000 in annual maintenance (Barker, 2005)

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[7] Redflex is the traffic camera technology company that provides equipment for the current Victorian point-to-point system.
[8] Note that some of these cost estimates are dated. Consideration should be made regarding the strength of the relevant currency at the time the estimate was given compared to the current market situation.
[9] At the time of project inception, DPTI went by the former title of the Department for Transport, Energy and Infrastructure (DTEI).
[10] This budget also includes the secondment of a full-time project manager.
[11] Speed Check Services is the traffic camera technology company responsible for all of the point-to-point systems currently used in the United Kingdom.

- In Scotland, the two year trial on the A77 that began in 2005 was predicted to cost £1.1 million (A77 Safety Group, 2008)
- In Austria, a point-to-point system in the Kaisermühlen tunnel near Vienna was installed in 2003, with annual costs estimated at €207 950 over a 10 year period at 4%p.a., including implementation costs of €1.2 million and €60 000 annually for maintenance (Stefan, 2006)
- There is likely to be economies of scale associated with more extensive implementation of point-to-point systems, such that in 2005 the Scottish Government reported that a 15 camera system installed in Strathclyde cost £775 000 (Cameron, 2008).

A cost-benefit estimate was provided in a recent forward design study conducted by AECOM Australia regarding the implementation of point-to-point speed enforcement in the Australian Capital Territory (Lynch, 2010). The analysis considered social cost savings associated with crash reductions[12] as well as implementation costs and operational costs of the system over a period of 10 years[13], including design and project management, back-office interface development, communications costs, maintenance and replacement and infringement processing costs. Total capital and recurrent costs were estimated at $1 776 000 over 10 years, while the reduction in costs associated with crashes was estimated between $8 342 000 and $13 631 000. Thus, a net economic benefit of $6 567 000 to $11 855 000 was estimated, equating to cost-benefit ratio of between 7.4 and 12.5[14] (Lynch, 2010).

Given the relatively high costs associated with point-to-point enforcement there must be a number of benefits to the method to make it cost-effective. Strengths of the technology include: the ability to simultaneously monitor multiple lanes of traffic and all vehicle types; constant enforcement 24 hours a day, seven days a week, regardless of weather conditions; use of technology that is highly accurate (Malenstein, 1997); and, remote set-up and operation. Furthermore, the enforcement technique is intended to reduce traffic congestion (Collins, 2007a, 2007b; Collins & McConnell, 2008; Malenstein, 1997; Schwab, 2006; Stevens, 2007) and subsequently have a beneficial impact on the environment by reducing harmful vehicle emissions (Collins, 2007a, 2007b; Collins & McConnell, 2008; Speed Check Services, 2009b; Stefan, 2006).

Cameron (2008) investigated the potential benefits of point-to-point speed enforcement in Western Australia. The report concluded that the technology showed promise as an effective speed enforcement method on highly-trafficked urban freeways and highways and particularly dangerous sections of rural highways. The study involved an economic analysis[15], with a total of 40 road links[16] within the state identified where it was estimated

[12] Anticipated crash reductions were estimated from Nilsson's Power model.
[13] Using a discount rate of 7%.
[14] Revenue from infringement notices was excluded from the cost-benefit analysis (CBA) in order to justify the systems on their road safety benefits. The authors estimated that, depending on traffic volumes and infringement rates, revenue from infringement notices could repay capital costs associated with the infrastructure in less than 12 months (Lynch, 2010).
[15] Data used to perform the economic analysis included information on the costs of crashes (based on Bureau of Transport Economics, 2000 and adjusted using the Consumer Price Index), estimated system and infrastructure costs (provided by Redflex), costs associated with processing speeding offences detected photographically (provided by the Western Australian police), and crash history, traffic volume and road demographics (provided by Main Roads – Western Australia). See Cameron (2008) for more detail.
[16] An additional 21 links were identified in metropolitan Perth but were deemed problematic because of numerous opportunities for access and egress along each link. However, it was subsequently

that point-to-point speed enforcement would have a benefit-cost ratio of 10 or greater. Indeed, the top ten sites were estimated to have a benefit-cost ratio of 27.9. It was estimated that, if installed, the technology would reduce serious and fatal injury crashes by 33.3% and medical treatment crashes by 12.6% (see Table 3.3 for more detail). A benefit-cost ratio (BCR) of 10.4 was estimated for point-to-point speed enforcement implementation on sections of Perth metropolitan freeways, 16.5 on sections of urban highways, and 15.8 on sections of rural highways.

Table 3.3: Freeways and highway links warranted for point-to-point speed enforcement in Western Australia.

Area	Road type	Total length of links (km)	Speeding tickets p.a. (short-term)	Fatal & hospital admission crash reduction	Medical treatment crash reduction	System capital costs ($000s)	Benefit-cost ratio
Perth Metro	Freeways	74	496 758	33.3%	12.6%	4 900	10.4
	Other links in top 40	248	218 210	33.3%	12.6%	4 450	16.5
Non-metro	Links in top 40	2 990	133 591	33.3%	12.6%	11 800	15.8

Source: Cameron (2008; p.45).

In addition, a number of empirical studies have shown that fixed and mobile speed camera operations tend to have site-specific effects and are susceptible to time and distance halo effects (Champness, Sheehan, & Folkman, 2005; Christie, Lyons, Dunstan, & Jones, 2003; Elliott & Broughton, 2005; Hess & Polak, 2004; Vaa, 1997). The premise of point-to-point enforcement as a deterrent to speeding is that it encourages motorists to reduce speed and comply with the limit over a longer section of the road network, compared to fixed or mobile cameras (Barker, 2005).

There is no doubt that point-to-point technology is a relatively expensive endeavour in comparison to alternative speed enforcement options. Although only a handful of cost-benefit analyses have been performed the findings are promising and suggest excellent returns on the investment in social and economic savings.

In a report prepared by the Highway Agency and Atkins Consultants (2009) in relation to a point-to-point system located on the A14 from Huntingdon to Cambridge in England, substantial cost benefits were reported. Specifically, the report found that in the first year of full-implementation there was a significant annual crash cost reduction of £2.2m. More recent estimates calculated three years after the implementation of the system suggest an annual overall cost-benefit of the system of £4.3m (Collins, 2010).

Thornton (2010) estimated the cost-effectiveness of wide-scale implementation of point-to-point on United Kingdom motorways in regard to costs associated with fuel consumption and emissions only. The cost for installing a point-to-point system was estimated at £25 000 per mile while estimated social costs of carbon emissions were £80 per tonne. It was estimated that point-to-point enforcement of the 70mph national speed limit on motorways could produce reductions in CO_2 of 850 tonnes per mile per year, equating to a carbon saving of £68 000 per mile, and a cost-benefit ratio of 2.72. Moreover, enforcing a 50mph speed limit

agreed in discussion with Western Australian stakeholders, following the completion of Cameron's 2008 report that, regardless of the number of opportunities for access/egress, the technology would appropriately monitor the speeds of those motorists who passed through the initial and subsequent camera sites of point-to-point systems and detect those exceeding the limit. As such, limited opportunity for access and egress was not considered to be a criterion for site selection.

could produce a cost-benefit ratio of 7.08. It should be noted that these estimates do not include savings in social costs associated with traffic crashes or congestion which would likely increase the benefits.

A cost-benefit analysis of the implementation of point-to-point enforcement in the Kaisermühlen tunnel in Austria, considering both impact on road traffic emissions and costs associated with crashes, suggested a benefit-cost ratio of 5.3 (Stefan, 2006). In the United Kingdom, the use of a temporary point-to-point speed enforcement system during the widening of the M1 between Junction 6a and 10 was predicted to have produced a £13.6 million benefit in social costs due to casualty reductions in the two years of implementation (Speed Check Services, 2008a). During the trial of point-to-point in Kent on the M1 in 1999, estimated social costs associated with crashes were reportedly reduced by 50% (Palmer, 1999). Finally, Dalbert (2001), in an evaluation of the first year of the Nottingham point-to-point trials, reported a 52% reduction in serious injury crashes. This represented a cost-benefit of US$97 000 per crash in injury and damage costs.

Finally, there are also associated benefits for police and transport agencies associated with using Intelligent Transportation Systems such as Automatic Number Plate Recognition (ANPR) and optical character recognition (OCR), point-to-point cameras and digital technology. Use of these advanced enforcement methods creates a centralised and automated platform from which to monitor multiple offences and is more efficient than traditional methods. Specifically, the digital technology used in point-to-point camera systems allows for more efficient administration of infringement notices of offending motorists than traditional wet film methods which require couriering, development and scanning, given that information is collected in real-time and in digital format in a point-to-point system. In addition, police human resources can be more efficiently allocated to other duties (Kursius, King, & Russo, 2003; Young & Regan, 2007).

3.7 Comparison of effects between point-to-point and other types of enforcement

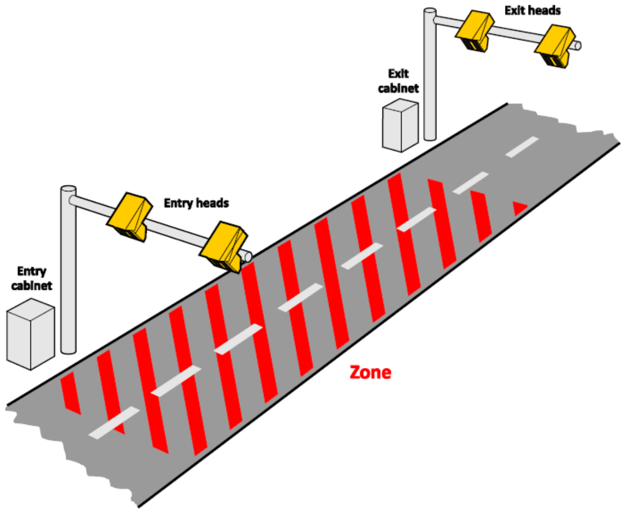
Only a handful of studies have systematically compared the effects of point-to-point speed enforcement with other approaches. During the widening of the M8 motorway at Junction 28, a unique natural experiment was conducted comparing the impact of instantaneous speed enforcement used during phase one of the works and point-to-point used during phase two (Charlesworth, 2008). Offence rates were 11 times lower during operation of the point-to-point system and non-injury collisions were reduced from 13 to 0, comparing the year before and after implementation of the temporary system.

In a four-year evaluation of speed cameras of all types in Britain, point-to-point speed enforcement at Nottingham and Northamptonshire was compared to 502 fixed camera sites and 1 448 mobile camera sites (Gains, et al., 2005). All types of cameras produced reductions in average speeds, 85th percentile speeds and the proportion of vehicles exceeding the speed limit at the camera site. In all instances fixed speed cameras produced the greatest reductions, followed by point-to-point cameras and mobile speed cameras. Specifically, reductions in average speeds of 5.3mph, 1.6mph and 1.3mph, respectively were observed, while 85th percentile speeds were reduced by 7.6mph, 3.6mph and 1.6mph, respectively. Finally, reductions in the number of vehicles exceeding the speed limit of 70%, 53% and 18%, respectively, were observed. Point-to-point speed enforcement was found to be especially effective in reducing the number of vehicles exceeding the speed limit by more than 15mph. Indeed, point-to-point speed enforcement led to a reduction of 100% in excessive speeding, compared to reductions of 91% and 36% for fixed and mobile cameras, respectively. The study is limited however by the small number of point-to-point camera sites included in the data as well as the fact that the findings relate to changes in behaviour at the camera site and do not take into account time and distance halo effects.

Also in the United Kingdom, two studies (Gains, Humble, Heydecker, & Robertson, 2003; Keenan, 2002) evaluated the trial of point-to-point speed enforcement on the M1 in Nottingham in July 2000 and compared the technology to fixed camera enforcement. Gains and colleagues (2003) found that while both point-to-point and fixed cameras reduced crashes, there were no statistically significant differences between the approaches. It should be noted however that the trial involved two cameras approximately half a kilometre apart and this short distance might explain the lack of difference in crash reductions. In addition, while no significant differences were observed in crash reductions the difference in cost-effectiveness is unclear. Similarly, Keenan (2002) also found crash reductions associated with point-to-point speed enforcement but reported increased crash rates at all three fixed camera sites analysed. He argued that point-to-point speed enforcement has the capability of impacting upon vehicle speeds over a greater length of the road network, compared to fixed cameras which tend to have more site specific effects. While there may be some increased effectiveness by placing two fixed cameras in close proximity to one another, this effect is still not as substantial as when a point-to-point system is employed. The increased crash rates may be explained by the typical behaviour displayed by many motorists at fixed camera sites whereby they brake suddenly as they approach the site and then accelerate sharply again after it.

4. TECHNOLOGICAL OVERVIEW

Point-to-point enforcement involves the installation of a series of cameras at multiple (e.g., two or more) locations along a particular section of the road network (see Figure 4.1). As a method of speed enforcement, point-to-point systems capture an image and record the vehicle registration data of each vehicle as it enters the system at the initial camera site. Additional images and data are recorded at subsequent camera sites within the system and matched to the initial data. ANPR and OCR technology are then used to identify vehicle registration details.



Source: RedSpeed International personal communication.

Figure 4.1: Basic diagram of a point-to-point speed enforcement system.

The average speed of a vehicle is calculated using data collected from at least two points within the system. Specifically, average speed is calculated by dividing the specified distance between those two camera sites by the time taken for the vehicle to travel between these two camera sites. This process is shown in the form of a simple equation below in Equation 1.

(Distance / Time) x 3.6 = Average speed (km/h) *Equation 1*

If the corresponding average speed of a vehicle exceeds the legal posted speed limit for that section of the road network, image and offence data (e.g., time, date, speed, etc) are transmitted to a central processing unit from the local processor via a communication network. While most systems incorporate an enforcement tolerance, the specific threshold employed varies by jurisdiction. While there are capabilities for the back-office of a system to be fully automated, almost all current installations of point-to-point throughout the world involve some degree of human verification to assess the validity of detected infringements (the closest example of a fully automated system is operated in the Netherlands, see Section 5.3.3). Validated offences are subsequently issued with an infringement notice by the relevant authorities while data on vehicles not exceeding the speed limit are typically erased.

The underlying premise of point-to-point speed enforcement is that reductions in vehicle speeds are achieved over a larger section of the road network. Comparatively, a common finding associated with instantaneous speed cameras that has led to criticism and scepticism of their effectiveness, is that they have a minimal zone of influence typically restricted to the immediate vicinity of the camera. Indeed, vehicle speeds have been reported to return to pre-camera levels, or even to speeds greater than that of pre-camera levels, as little as 200 metres after the instantaneous speed camera site (Champness, et al., 2005; Charlesworth, 2008; Keenan, 2002). However, there is also emerging evidence to suggest vehicle speeds return to pre-section levels once vehicles exit sections enforced by point-to-point camera systems (stakeholder consultations).

For point-to-point systems to be reliable and accurate the precise distance between camera sites must be known and the technology employed to assess the time taken to travel the distance must be precisely synchronised. Appropriate maintenance schedules must be implemented and adhered to in order to ensure ongoing accuracy. Theoretically, there are no limitations to the distance between subsequent camera sites, however factors such as the opportunities for access and egress and availability of appropriate communication networks undoubtedly affect such decisions.

In addition to being employed as an approach to speed management, point-to-point technology, or more accurately ANPR/OCR technology, has the capability of being used to continuously monitor a range of other behaviours and offences (Kallberg et al., 2008; Wiggins, 2006). These include:

- Seat belt use
- Tailgating
- Identification of stolen, unregistered, unlicensed vehicles and motorists
- Petrol station/parking payment violations
- Inappropriate overtaking
- Red light violations
- Toll evasion
- Bus lane enforcement
- Access control (e.g., to restricted areas)
- Traffic monitoring (e.g., journey time and origin destination information)
- Counter-terrorism.

While these uses of the technology are important, this report focuses solely on the use of point-to-point systems for the purpose of speed enforcement.

Typically, point-to-point systems have a number of common components, and these similarities can be seen in implementations of the technology in Australia and elsewhere. These include:

- Cameras/Illumination
- Infrastructure (e.g., camera housing/mounting; cabling; clocks; power source)
- Processors
- ANPR/OCR engine and software
- Communications network
- Central processing unit/back office.

However, most systems differ on a number of minor technical, operational and infrastructure characteristics and these distinguishing features can heavily influence system operations and costs. The following sections outline the various approaches available when implementing point-to-point systems and highlight the advantages and disadvantages associated with various elements.

While this overview is relatively comprehensive, the authors recommended Lynch (2010) and Wiggins (2006) for further information on the technological aspects of point-to-point systems. Furthermore, inspection of product guides from system manufacturers also provides more specific information on technological characteristics of particular systems.

4.1 Cameras/Illumination

4.1.1 Number of cameras and camera sites

At a minimum, cameras must be installed at the entry and exit points of the enforcement corridor, however contiguous enforcement corridors can also be implemented (e.g., point-to-point-to-point). Multi-point systems can also be installed whereby numerous entry and exit camera sites are linked to every other entry and exit camera site. Decisions associated with the use of different systems will typically depend on the length of the enforcement corridor and opportunities for access and egress (e.g., on-ramps and exits within the corridor), as well as budget considerations.

The specific number of cameras at each camera site differs from system to system. Commonly, a camera site will involve multiple cameras employed to monitor multiple lanes and/or directions of traffic. Systems typically involve a designated camera employed to monitor each lane of traffic on the enforced route. However there is also the option of using a single camera to enforce multiple lanes (Lynch, 2010). Moreover, a number of systems employ multiple cameras for each traffic lane that is enforced, including plate and scene cameras. Plate cameras, as the name suggests, are positioned such that they capture a relatively close image of the number plate of the vehicle. On the other hand, scene cameras capture a wider angle view, typically encompassing the entire vehicle, as well as the lane positioning.

4.1.2 Rearward-facing cameras, forward-facing cameras or both

Cameras can be positioned such that they capture the front of a vehicle (forward-facing cameras), rear of a vehicle (rearward-facing cameras) or both (Lynch, 2010). Obviously, there are advantages and disadvantages associated with each approach and decisions regarding which approach is most efficient typically depend on system objectives, the mix of traffic to be enforced and costs. Specifically, while forward-facing cameras allow for driver identification (when cameras are of sufficiently high resolution), these systems are not capable of capturing offending motorcycles whose number plates are on the rear of the vehicle (Lynch, 2010).

On the other hand, rearward-facing cameras, while capable of detecting speeding motorcyclists, do not identify motorists. Thus, the use of rearward-facing cameras requires the onus of responsibility to be with the owner of the vehicle, rather than the driver. Other issues include that plate recognition can be complicated or obstructed by trailers or caravans, and there is typically greater heterogeneity in the placement of rear number plates and the presence of bumper stickers and other forms of text may confuse the ANPR/OCR engines (Lynch, 2010; Wiggins, 2006). Adverse weather conditions can also impact upon the ability for rearward-facing cameras to capture number plates (e.g., if roads are wet and water is being sprayed by the vehicle’s tyres).

While having both forward- and rearward-facing cameras provides the benefits of each approach, this is only achieved at a considerable additional cost (Lynch, 2010).

4.1.3 Resolution, colour and type of camera equipment

The specific resolution of cameras typically depends on system requirements and will invariably be influenced by other system choices, including the number of cameras. High resolution cameras have the benefit of being able to provide wide angle shots at a resolution large enough to perform the required licence plate recognition, however require greater data processing systems as a function of the larger file sizes of images captured (Lynch, 2010). As a result, many systems employ low resolution cameras specifically designated for each lane of enforced traffic.

In addition, cameras can be digital or analogue. While digital cameras offer higher resolution, analogue cameras typically have higher capture rates given that a greater number of photos can be taken in an equivalent period of time. Reduced system requirements are also associated with analogue cameras due to the smaller size and resolution of each captured image (Wiggins, 2006).

Finally, cameras can be monochrome or colour. Monochrome cameras have a number of advantages, including the capability to be used with infrared illumination and the fact they are more sensitive and require lower levels of ambient light (Wiggins, 2006). For this reason, monochrome cameras are most commonly used in point-to-point systems.

4.1.4 Illumination

Given that point-to-point enforcement systems are operated continuously (e.g., 24 hours a day), it is important for systems to have the capability to provide additional illumination during low-light and night-time conditions. A number of options are available, including continuous illumination, triggered illumination and infrared illumination (Wiggins, 2006). Continuous illumination is the most expensive approach and increases the likelihood of maintenance requirements, while triggered systems, such as flashes, have the potential to distract motorists.

Infrared illumination is most commonly employed, particularly when monochrome cameras are used. The most popular approach is the use of pulsed infrared light emitting diode (LED) illuminators (Wiggins, 2006). In addition, the illuminator is typically offset to prevent reflection directly back to the camera, allowing the system to accurately identify number plates with reflective fonts or surfaces (Lynch, 2010).

4.1.5 Camera activation system

Cameras can be activated in a number of different ways, including continual video-streaming to capture images, or vehicle-activated methods such as lasers, radars or induction loops (Lynch, 2010). Trials conducted by the RMS in New South Wales have suggested that vehicle capture rates are higher when cameras are triggered by induction loops (Lynch, 2010), however such an approach can have a relatively short working-life and thus increase maintenance requirements.

4.2 Infrastructure

4.2.1 Camera housing

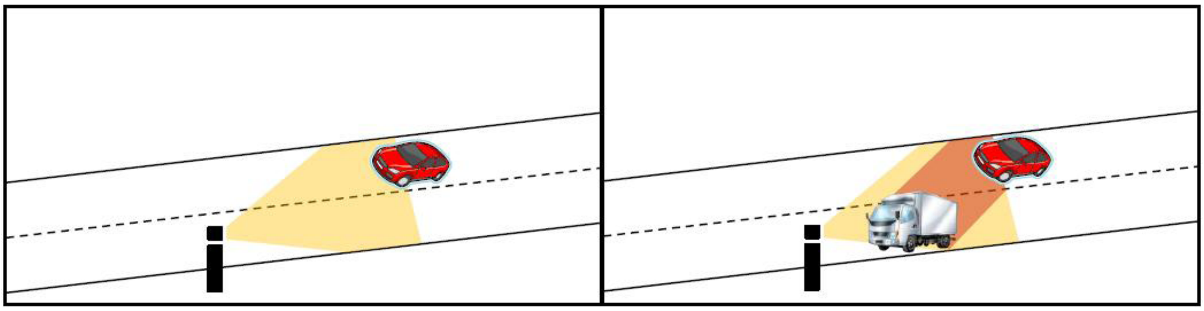
There are various options for camera housing (Redflex Traffic Systems, 2007). The specific level of enclosure typically depends on the degree of protection required from various weather conditions or anticipated tampering or vandalism. Typically, the most protective housing involves a closed system that does not ingest external air, allowing for the use of the technology in even the harshest of environmental conditions.

4.2.2 Mounting

There are two main approaches to the installation of point-to-point systems: permanent or mobile/temporary. Permanent systems are typically mounted to roadside structures, such as poles, or on existing or purpose-built infrastructure such as gantries, bridges or overpasses. Conversely, mobile systems are typically vehicle- or trailer-mounted versions of the same technology and are most commonly installed as a temporary application of the enforcement method during roadworks (Cameron, 2008).

As a starting point in relation to permanent systems, a decision must be made regarding how the cameras will be installed to monitor the traffic. There are two common approaches: side-mounted or overhead (Lynch, 2010). Side-mounted cameras (similar to operations in Victoria, New South Wales and Queensland) are typically fixed to poles located on the roadside verge or median. Conversely, overhead cameras, which are more commonplace in the United Kingdom and throughout Europe, are affixed to existing or purpose-built infrastructure and generally involve cameras for each designated lane.

While side-mounted cameras are a cheaper approach, they typically have poorer capture rates given that larger vehicles (e.g., trucks, buses) can obstruct the view of the camera from detecting vehicles in other lanes (see Figure 4.2). Indeed, trials conducted by the RMS in New South Wales have suggested that vehicle capture rates are greater when overhead installations are used (Lynch, 2010), however little information is available regarding the exact impact of side-mounting on the proportion of vehicles monitored.



Source: AECOM (2010) cited in Lynch (2010).

Figure 4.2: Graphical representation of potential heavy vehicle obstructions from roadside mounted cameras.

On the other hand, overhead installations designating a camera to each lane increase capture rates and reduce system workload requirements. This approach is considerably more expensive given that it requires more extensive infrastructure. That said, costs associated with infrastructure can be somewhat mitigated if existing infrastructure is utilised (Lynch, 2010).

An alternative option, recently adopted in the United Kingdom, involves roadside cantilevers with arms that extend over the carriageway (see Figure 4.3). Such an approach allows for the use of a designated camera for each lane of traffic, while substantially reducing infrastructure costs (Lynch, 2010). In essence, it combines the advantages of each of the approaches to mounting point-to-point cameras. However, consideration of structural and design issues, such as vibration from passing vehicles and the effects of movement from wind, must be considered for effective and reliable implementation of such an approach (Lynch, 2010). It could also be argued that the approach makes the cameras more visible and could add to the deterrent effect of the enforcement efforts.

Source: Vysionics (2010).

Figure 4.3: Implementation of point-to-point using both side-mounted and overhead approaches.

4.2.3 Cabling

The amount of cabling required for a point-to-point system, and the complexity of the cabling, largely depends on the degree to which the system is integrated. As Wiggins (2006, p.4) explains:

> *'Systems that utilise separate cameras, illuminators and processors will require the most complicated cabling scheme. A simpler cabling arrangement would be required where combined camera and illuminator units are connected to a separate processor. Fully integrated systems employing combined cameras, illuminators and image processors may only need power to be connected'.*

A number of approaches to cabling are available, each with particular advantages and disadvantages. These include coaxial video cables, optical fibre cabling, copper cabling, twisted pair cabling and the use of wireless transmitters and receivers. Coaxial video and copper cabling approaches are not typically useful for larger distances (e.g., greater than 100m). Fibre optic cabling and wireless approaches represent a more effective approach when the distance between camera sites is greater than 100 metres, however fibre optic cabling can be costly to implement and wireless transmissions often requires a line of sight between cameras. Thus, twisted pair cabling is typically the most popular cabling approach employed, particularly when using differential, as opposed to composite, video signals (Wiggins, 2006).

4.2.4 Time clocks

Point-to-point camera systems must include time clocks that can provide date and time stamps associated with captured images. Such a process creates a vital evidentiary basis for enforcing infringements detected by the systems (Kursius, et al., 2003; Parliamentary Travelsafe Committee, 2008; Wiggins, 2006). The most common approaches are the use of Global Positioning Systems (GPS) technology and/or Network Time Protocols (NTP).

Two approaches to clock synchronisation are commonly adopted. The first involves synching the time on two devices with one another, while the second involves synching devices with the correct time. In all instances, NTP adopts the latter approach, such that devices connected to the NTP network periodically request time information from the NTP server and accordingly adjust their own internal clock. The Simple Network Time Protocol (SNTP) is a simpler version of NTP. While GPS can also be used in the same manner, problems can arise when GPS technology is used to synch clocks with one another (as they may not represent the correct time). Depending on legislative and evidentiary characteristics in a jurisdiction, such factors can have considerable implications for enforcement.

In short, it is fundamental that the technology used to measure date and time are synchronised to ensure the accuracy of the system, and that systems are regularly tested and certified. Indeed, many systems include safeguards to ensure the accuracy of clock synchronisation (Orozova-Bekkevold, Martinez, & Akkermans, 2007).

4.2.5 Power source

There is the ability for point-to-point systems to operate on both AC mains and DC power sources. In many instances, systems will be capable of operating via either, with permanent installations typically requiring mains power and mobile systems having a necessity to be able to support DC power supply (Wiggins, 2006). Access to appropriate power sources can represent a substantial cost when implementing a system, and thus can affect the specific location of camera sites.

4.3 Processors and servers

The primary processing requirement for point-to-point camera systems is that of the ANPR and OCR software, discussed in greater detail in the following section. That is, the primary processing requirement is the capturing and recognition of vehicle number plates and other associated data. According to Orozova-Bekkevold et al. (2007), point-to-point systems typically work in the following manner: images are captured at each camera site and converted into a specific file format (e.g., JPEG, TIFF, bitmap) for additional processing by the ANPR/OCR software. At the time the image is captured, information is also collected regarding the date, time and location of the offence, as well as the system parameters. These data, commonly referred to as a 'fingerprint' are collected at each camera site, with data from exit cameras systematically compared to entry fingerprints for the purpose of matching and the identification of offending vehicles.

While early point-to-point systems involved relatively extensive computer hardware, more recently, ANPR/OCR processing systems typically involve nothing more that small industrial PCs or laptop computers (Lynch, 2010; Wiggins, 2006). Systems also differ in relation to whether they are PC-based or embedded. Embedded systems, typically implemented as part of an overall device including hardware and mechanical elements, are designed to perform a single (or small number) of specific and dedicated functions. Conversely, PC-based systems are designed to be more flexible and to meet a broader range of end-user requirements

Typically, embedded processors provide a number of advantages. Indeed, embedded processors are generally more power-efficient, consuming as little as 5% of the power required for PC-based systems, thus representing a more cost-effective approach (Wiggins, 2006). The reduced power requirements also negate the need for cooling fans and produces increased system reliability. As a result, they are more suited to use with integrated systems and for use in more remote areas. Finally, as Wiggins (2006; p.3) explains:

> *'Another advantage of embedded processors is that they can implement a lot of the ANPR system's functionality in hardware that would normally be required to be implemented in software. This allows the majority of Central Processing Unit (CPU) time to be spent actually reading plates, rather than performing relatively mundane tasks, such as: locating the plate, choosing the best available plate image and JPEG compression of the plate and vehicle bitmaps'.*

Systems also differ in regard to whether this process is conducted at a roadside or central processor, which can adversely affect bandwidth requirements associated with communication networks (see Section 4.5). The processor can also be located at the actual camera site, rather than in a roadside cabinet. Most commonly, processors are located at the roadside location of the cameras, reducing system requirements and providing a more power-efficient and cost-effective approach. Indeed, roadside processors allow for the ANPR/OCR process to be conducted prior to data transmission. In such instances, images and other information are stored locally, with only data for offending vehicles transmitted to the central processing unit and data on non-offending vehicles deleted (Wiggins, 2006).

Obviously, the external storage and collection of data associated with roadside processors creates a number of ethical considerations regarding the security of such data. Numerous systems throughout Europe incorporate various safeguards against malfunction and are designed to automatically shut down when a malfunction is detected (Orozova-Bekkevold, et al., 2007). Specifically, local processors can be designed so that a series of matrices are used to continuously check for possible malfunctions. In addition, roadside cabinets can be designed to detect attempts of unauthorised physical breaches (e.g., vandalism) and all stored data can be immediately erased.

4.4 ANPR/OCR engine and software

One of the most fundamental technologies employed in point-to-point systems is the ANPR or OCR software, used to identify the letters and numerals on vehicle number plates. As noted above, the system processor extracts information from the data collated from this software, using a relational database. However, it is critical that the software, operating system and database are compatible to ensure adequate system functionality (Wiggins, 2006).

There are a number of approaches to the techniques adopted by ANPR/OCR software to automatically read vehicle number plates. The three most common approaches are: template matching, structural analysis and neural networks (Wiggins, 2006). Wiggins (2006) describes each of the three techniques, highlighting the advantages and disadvantages associated with each:

> *'Template matching is the method used by OCR systems designed for operation with scanned documents. It is not very tolerant to misaligned, obscured, dirty and damaged characters. Structural analysis uses a decision tree to assess the geometric features of each character's contour. This technique is more tolerant to poor quality number plates. Neural networks are trained by example instead of being programmed in a conventional sense. While learning to recognise a recurring pattern, the network constructs statistical models that adapt to individual characters' distinctive features. Neural networks tend to be more noise resistant and performance is not usually comprised under changing operational conditions. Training a neural network can be very time consuming'* (Wiggins, 2006; p.3).

4.4.1 Accuracy

The accuracy of point-to-point speed enforcement systems can be assessed in two ways: the capability to capture a vehicle number plate, and the accuracy in which ANPR/OCR engines read the number plate. All systems should be designed to have high vehicle detection rates, such that all (or at least almost all) vehicles travelling along the enforced section are monitored. However, the degree to which the plate recognition software can read the number plate can be affected by variations of plate styles (e.g., different plates used within the one jurisdiction or different plates used by other jurisdictions which may not be easily recognised by another jurisdiction's system) or plate condition (e.g., dirty, damaged). This latter point highlights the need for road authorities to encourage and enforce correctly placed and legible plates, as well as the importance of ensuring that all new plate styles can be detected by system cameras.

The most important element of number plate reading is that, when errors are made by the ANPR/OCR engine, they are consistent at both the entry and exit site. Such errors still allow for the enforcement of that vehicle, although highlight the need for some degree of manual verification at the back-office. When errors differ between the entry and exit sites, offending vehicles are not detected, thus reducing the enforcement effectiveness of the system.

4.5 Communications network

There are a variety of options for transmitting ‘fingerprint’ information from the local processer to the back-office. These include Ethernet, wireless technologies (e.g., WiFi, GSM, GPRS, CDMA or 3G) and fibre optic cables. Often fibre optic communication networks are already installed along motorways and thus this can provide a cost-effective approach (Wiggins, 2006).

Given the sheer volume of data to be processed, most systems are capable of saving and transmitting fingerprint data in very small (e.g., as little as 1KB each) file sizes (Orozova-Bekkevold, et al., 2007). However, initial images captured by the point-to-point system will vary depending on other system components. For example, analogue cameras generate images of a smaller size (up to 50kB) compared to digital cameras (500kB to 2MB). Therefore, traffic flow and processor capabilities of the system must be considered (Wiggins, 2006).

In addition, the amount of information sent to the central processing unit differs depending on the type of processor employed. That is, roadside processors may allow for the ANPR process to be conducted prior to data transmission, with images stored locally and only information for vehicles detected committing an offence transmitted to the central processing unit, substantially reducing communication bandwidth requirements (Wiggins, 2006).

There are also numerous options regarding the level of detail of information included in the data block (Lynch, 2010). Indeed, Lynch (2010) outlines the various elements of content that can be included in the data block, including speed limit (which might include enforcement tolerance), capture speed, lane information, date and time of the infringement, location of the infringement, image and operator details.

Typically, to address issues associated with data security, information transmitted through the communication networks is encrypted. Numerous other security protocols can also be developed.

4.6 Back office/Central processing unit

The back office represents the central processing unit whereby data from the local processor are transmitted, via a communication network. As stated in the previous section, the amount of data transmitted to the back office varies from system to system. However, point-to-point systems generally perform a number of processing tasks at the local processor, transmitting only data and images associated with offending vehicles to the central processor.

The back-office may be fully automated or involve varying degrees of human verification to assess the validity of detected infringements. Validated offences are subsequently issued with an infringement notice by the relevant authorities while data on vehicles not exceeding the speed limit are erased. Generally, some level of human verification is recommended to ensure the validity and reliability of detections. Moreover, in the instance of system malfunctions, human verification may represent the quickest and most efficient means of identifying the anomaly and ensuring incorrect infringements are not issued. Such a practice may serve to safeguard against reductions in the perceived legitimacy of the system.

While most systems incorporate an enforcement tolerance, the specific threshold employed varies by jurisdiction. Systems with contiguous enforcement corridors also commonly employ multiple infringement policies to protect motorists against receiving multiple infringement notices for the same offence. These legislative and policy issues are discussed in the following section.

4.7 Legislative and policy issues

There are a number of additional issues that must be addressed when installing point-to-point speed enforcement systems, over and above technological characteristics, including a myriad of legislative and policy considerations. These issues are covered in more detail throughout the following sections of this report, however a brief overview is provided here.

Prior to the initial implementation of a point-to-point enforcement system, most jurisdictions require type approval and certification of the technology. Legislative requirements differ between jurisdictions and are dependent on technical issues such as accuracy and reliability of the equipment and legislative issues such as driver identification. There is also a need to distinguish between average speeds and average speed limits, such that new legislation may be required to allow systems to operate along enforcement corridors where speed limits are not discrete. Surveyed distance between the camera sites and the synchronisation of time clocks also typically require certification.

In addition, following the installation of the system, it is necessary to ensure appropriate system maintenance schedules and safeguards against malfunctions are in place. One of the most transparent and reliable approaches to ensuring this is to enact legislation or establish policy requirements. Jurisdictions throughout the world vary substantially regarding the length of time between mandated checks, the comprehensiveness of checks performed and the degree to which checks are legislated or simply policy recommendations.

A similar approach is also generally required to ensure appropriate signage of point-to-point systems. Indeed, the majority of systems implemented around the globe are operated overtly using signage to alert drivers that they are entering an enforcement corridor. However, the degree and specificity of signage differs between jurisdictions. Specifically, the degree of signage may range from a single sign prior to the enforcement corridor to multiple signs prior to and within the enforced section. In addition, the specificity of information incorporated on signs may range from specific reference to average speed checks to more general notification of the presence of speed cameras. The latter may be a more appropriate signage approach for systems where cameras have the capability of capturing instantaneous speeds, as well as calculating average speeds. The degree to which signage requirements are legislated or simply policy recommendations also differs between jurisdictions.

A particular issue relates to systems involving contiguous enforcement corridors or concurrent instantaneous speed measurement capabilities. Specifically, such systems usually require a multiple infringement policy to protect motorists against receiving multiple infringement notices for the ‘same’ offence. While the specific characteristics of these policies differ between jurisdictions, they typically give weight to more serious infractions (e.g., higher degree over the posted speed limit) or to the average speed offence, given the persistent nature of the behaviour.

Finally, as stated in the previous section, there is substantial between-jurisdiction heterogeneity regarding the enforcement tolerances associated with point-to-point speed camera systems. Indeed, a number of socio-political factors are likely to influence the enforcement threshold in a particular jurisdiction and it is possible that different tolerance levels may be used within the one jurisdiction for different types of speed detection devices.

Given the greater persistence and longevity of speeding behaviour associated with average speed offences, it has been suggested that a lower enforcement threshold could be applied to point-to-point enforcement compared to instantaneous speed checks (Cameron, 2008; Lynch, 2010).

4.7.1 Potential legislative and ethical barriers to point-to-point implementation

A number of jurisdictions may also need to consider legislation regarding whether the onus of infringement responsibility lies with the driver or the vehicle owner. While this issue is a primary factor impeding wide-scale implementation of point-to-point in a number of international jurisdictions, it is considerably less applicable to the Australian context. For instance, in Australia the onus is on the owner of the vehicle to identify the driver when an infringement is detected; however the nature of this onus differs between jurisdictions[17].

In contrast, many European nations require photographic identification of the driver, which is sometimes complicated by restrictions on storing identifiable photographs of passengers (Gil & Malenstein, 2007; Kallberg, et al., 2008). If the driver cannot be identified and the owner of the vehicle fails to nominate a driver, charges are typically dropped, often at great expense to police and transport authorities (Organisation for Economic Co-Operation and Development, 2006).

Concerns are also regularly expressed regarding the privacy and security of data stored by point-to-point systems (Benz & Oehry, 2003; Gil & Malenstein, 2007; Orozova-Bekkevold, et al., 2007; Parliamentary Travelsafe Committee, 2008). These concerns include ensuring the security of stored data, particularly at roadside processors. Moreover, privacy issues associated with the identification of motorists and the potential matching of license plate information with other databases must also be addressed. Finally, privacy and security of data concerns may be raised depending on whether the management of databases and the distribution of infringement notices is conducted by the Government or outsourced to a private organisation.

[17] Specifically, in some jurisdictions, the nature of owner onus allows the vehicle owner to identify another driver or make a statutory declaration indicating that they do not know who was driving the vehicle at the time of the offence. Consequently, there is potentially a need to tighten legislation in some jurisdictions.

5. FINDINGS FROM THE STAKEHOLDER CONSULTATIONS

Point-to-point enforcement represents an innovative approach to speed management that is becoming increasingly popular in many countries throughout the world. Nonetheless, the implementation of the approach has, to date, been largely limited to the United Kingdom, Europe and Australia. Not surprisingly then, the majority of stakeholder consultations were conducted with organisations within these jurisdictions. Specifically, the jurisdictions included in this section are:

- Australia and New Zealand
  - Including: Victoria, New South Wales, Queensland, South Australia, Australian Capital Territory, Tasmania, Western Australia and the Northern Territory
- United Kingdom
  - Including: England, Scotland and Northern Ireland18
- Europe
  - Including: the Netherlands, Austria, Italy, Switzerland, Belgium, Finland, France, Norway, the Czech Republic and Spain

This section of the report provides a comprehensive overview of the results of the stakeholder consultations. The results are presented by jurisdiction, in the order detailed above. Within the discussion for each jurisdiction, the findings are presented with a focus on each of the following areas:

- Extent of the use of point-to-point speed enforcement systems
- Description of the technological characteristics and system capabilities
- Discussion of the operational characteristics of the systems
- Discussion of the legislative requirements for point-to-point enforcement systems
- Discussion of broader speed management issues, both directly and indirectly relating to point-to-point speed enforcement (e.g., public education, evaluation, importance to overall speed management).

5.1 Australia & New Zealand stakeholder consultations

Recently, a number of Australian jurisdictions have progressed with the implementation of point-to-point speed enforcement in trial and full implementation phases. Indeed, according to the National Road Safety Strategy 2011-2020, the introduction of point-to-point speed enforcement systems is highlighted as a high-impact action in best practice speed management (Australian Transport Council, 2011). Victoria was the first Australian jurisdiction to implement the technology, with New South Wales, Queensland and South Australia following suit more recently, in either fully operational or trial form. In addition, the Australia Capital Territory is aiming to implement their first point-to-point speed enforcement

[18] While some information is provided on the extent of the use of point-to-point in Ireland, no organisations from this jurisdiction took part in the stakeholder consultation phase of the research. Thus, no information is provided regarding the technological, operational and legislative characteristics of point-to-point implementation in the country.

system in late 2011. Finally, Tasmania is actively considering introduction of the technology in the near future.

5.1.1 Victoria

5.1.1.1 Extent of use of point-to-point speed enforcement

Victoria was the first Australian jurisdiction to implement a fixed point-to-point road safety camera system as a tool for general speed enforcement. In April 2007, the enforcement approach was implemented on a 54-kilometre stretch of the Hume Highway between the Western Ring Road to approximately 80 kilometres North of Melbourne’s CBD. The implementation involves five camera sites monitoring vehicle speeds in both directions along four contiguous sections of road (8, 14, 7, and 25 kilometres in length, respectively). While there are camera sites monitoring contiguous sections of road, each section works independently, such that average speeds are only calculated for adjacent camera sites. For example, the average speed of a vehicle is determined based on the first and second camera sites rather than between the first and third camera sites.

The exact locations of the camera sites are shown in Table 5.1 and comprise four independent sections. Site selection was based on the high crash rate experienced on the highway[19], with the suitability of the sites identified by the Department of Justice and supported by Victoria Police and VicRoads. Not surprisingly, given that the enforced section of road spans 54km, there are opportunities for access and egress throughout the enforcement corridor. In three of the sections of the system the speed limit remains constant, with 1-section having a speed change approximately mid-way through the section.

Table 5.1: Location and characteristics of point-to-point speed enforcement systems in Victoria.

Location	Distance to next camera site	Max. speed limit
H18 – O’Herns Road, Epping	8 km	100 km/h
H26 – Amaroo Road, Craigieburn	8/14 km	110 km/h
H40 – Mt Fraser, Beveridge	7/14 km	110 km/h
H47 – Station Street, Wallan East	7/25 km	110 km/h
H72 – Broadford-Flowerdale Road, Broadford	25 km	110 km/h

Although fully implemented, the Victorian point-to-point system has been turned off since 15 October 2010 following a software fault that resulted in the incorrect issuing of nine speeding infringements associated with the system (Victorian Auditor-General's Office, 2011). An investigation revealed that while the point-to-point system was programmed to reject offences detected during periods of clock resynchronisation, a software error resulted in nine infringements not being rejected during this process (this process is discussed in greater detail in Section 5.1.1.2 below).

Indeed, upon reviewing infringements issued close to the time of clock resynchronisation, nine incorrectly issued infringements were identified (Victorian Auditor-General's Office, 2011). The Victorian DOJ also reviewed all infringements issued since activation of the point-to-point system in 2007, which identified that, from a total of 68,000 infringements issued since the activation of the system, the only incorrectly issued infringements were the

[19] However, it was noted that site selection for speed enforcement typically involves a process whereby, in addition to crash data and speed profiles, sites are selected such that a proactive approach of identifying potential crash sites (e.g., around areas of large residential growth) is adopted in order to prevent crashes in future.

same nine infringements previously identified. The nine invalid infringements were withdrawn and the camera vendor was administered a substantial fine as a result of the software fault.

The corrections currently being implemented to correct this issue are discussed in Section 5.1.1.3 below. The Victorian point-to-point system will remain deactivated until significant testing has been conducted, reviewed and then if fit-for-purpose, approved by the Minister for Police and Emergency Services (Victorian Auditor-General's Office, 2011). In addition, Victoria Police has reported that they will assess the system in its full capacity and from end-to-end for one month prior to any reactivation of the system. Victoria Police need to ensure that the functionality and accuracy of the point-to-point system, prior to reactivation, is fit-for-purpose.

5.1.1.2 Technological characteristics

The system, provided by Redflex, will involve both forward and rearward facing cameras (in order to facilitate both front and rear image capture of a vehicle). In addition, both scene and plate cameras are involved in the system. All of the camera sites will involve both forward facing scene and plate cameras and rearward facing plate cameras. The back-office system current limitations negate the use of rear facing cameras for point to point. That is, only the forward facing cameras are currently used. The cameras and infra-red flashes are mounted on separate roadside poles, with few significant issues raised regarding loss of line of sight. The decision to use a side-mounted approach was largely based on infrastructure costs. Guardrails were also constructed to comply with VicRoads safety requirements for roadside infrastructure. Attempts to vandalise the cameras have been reported to be rare.

The system has the capability to monitor all types of vehicles, including motorcycles, given that only front number plates are currently identified. (Note: In addition to point-to-point enforcement, other forms of enforcement are also used to detect speeding vehicles including motorcycles on this roadway, such as mobile camera and Victoria Police highway patrol enforcement.) Each of the two lanes of traffic in each direction of the highway is monitored by a designated camera, excluding the emergency lane[20]. The cameras are triggered by in-road sensors imbedded in the road surface. The systems are capable of both instantaneous speed and average speed measurements, however currently only average speeds are measured. The system has the capability to handle more cameras and additional data storage (Cameron, 2008; Lynch, 2010). Every vehicle is photographed by the system, regardless of the speed of that vehicle, creating a large amount of data that must be processed. All detected incidents are verified by humans.

Synchronisation of the GPS clocks is performed independently for each camera bank every minute and adjusted or stepped. It should be noted that all clocks drift to some extent over time, and that generally such drift does not substantially affect the calculation of average speed. Specifically, the system clocks are synchronised to a software clock during this process, however if the system is rebooting the clocks are set to synch to the hardware clock by default. As stated previously, the system software was programmed to reject offences detected during periods of clock resynchronisation.

Following the software faults identified in the previous section, a number of changes have been instituted and are currently undergoing an extensive fit-for-purpose trial. The most significant change is the installation of a secondary speed measurement device similar to those employed in other fixed road safety camera systems in Victoria. Specifically, the

[20] There is some anecdotal evidence to suggest some motorists, including heavy vehicle operators, attempt to use the emergency lane to avoid detection.

secondary system runs parallel to the primary speed measurement system and employs technology that was already in place due to the ability for the system to measure instantaneous speeds, with the main requirement being a modification of the system software.

A detailed overview of the technological characteristics of the Victorian point-to-point speed enforcement system is provided in Table 5.2.

5.1.1.3 Operational characteristics

While Redflex is responsible for maintaining the system (e.g., central processing unit and cameras), they have no access to vehicle registration or driver data obtained by the back-office processing system (Cameron, 2008). The Traffic Camera Services Provider (i.e. Serco) maintains the back-office processing system and as a result, verifies all incidents captured by the road safety camera network. It is a requirement that each incident be reviewed at least twice. The Traffic Camera Office (TCO) within the Victorian Police is the authorising issuing authority and therefore must authorise all verified incidents into infringement notices. The Infringement Management and Enforcement Services Provider (i.e. Tenix) are responsible for the administration and processing of infringement notices. It must be noted that incidents are disseminated five days after the offence to ensure that maintenance checks are appropriately carried out and that the system is operating accurately and reliably. Such maintenance checks (e.g., in-road sensors and time interval measurements) are conducted regularly and tested by independent Testing Services Providers. Indeed, maintenance checks and testing are performed on various components of the system on a daily, monthly or quarterly basis.

Prior to implementation and during operational activities, the system undergoes routine testing and certification. For evidentiary purposes when enforcing an average speed offence, the distance between camera sites is determined by a licensed surveyor[21] and a certificate as to the evidence of road distance is provided which authenticates the shortest (legal) distance between each of the camera sites. Certification of road distance is updated on an as required basis. The GPS technology contained within the camera system is tested routinely to ensure the synchronisation of the time clocks.

To address the faults identified in October 2010, the camera vendor has since developed software changes, which are currently being extensively tested in a fit-for-purpose trial, with the testing procedure being monitored by an independent engineering firm with expertise in road safety camera technology (Victorian Auditor-General's Office, 2011). In addition, a secondary speed measurement system is currently being installed for the point-to-point system as noted in the previous section. The secondary speed measurement system will be a unique feature in point-to-point speed enforcement systems within Australia. In addition, stakeholders reported that additional costs can be minimised by adopting a secondary system that is consistent (e.g., similar technology) with the primary speed measurement system. The Victorian Auditor General’s report found that if the secondary speed measurement system had been in place since the initial activation of the Victorian system, it is unlikely that the incorrect infringements administered in late 2010 would have been issued (Victorian Auditor-General's Office, 2011).

[21] A licensed surveyor within the meaning of the (Victorian) Surveying Act 2004 who is approved for the purposes of the Act by the Surveyor-General or by the Corporation (VicRoads).

Table 5.2: Technological overview of point-to-point speed enforcement systems in Victoria.

System Component	Specific Characteristics
Cameras & Illumination	
Number of cameras	Two designated cameras (scene and plate) per lane at 10 sites (5 camera sites – bi-directional). Six of the ten sites involve both rear and forward-facing cameras
Number of camera sites	10 camera sites – 5 in each direction of traffic
Camera resolution	1.4 Megapixels
Digital or analogue	Digital
Monochrome or colour	Both. Front scene image in colour (based on infra-red illumination), front plate image in monochrome
Camera activation	In-road sensors– pavement at site 200m deep to ensure reliable operation of sensors (lifespan of approx. 12-18 months)
Forward or rearward facing	Both. However only forward facing cameras are currently used
Camera per lane or multiple lanes	Designated camera per lane
Illumination approach	Infra-red
Infrastructure	
Camera mounting approach	Pole mounted to side of road. One pole mounts the camera while another is used to mount the flash
Purpose built or existing	Purpose built. Guardrails were also constructed to protect vehicles from hitting the poles should they crash at the site
Camera housing approach	Standalone enclosure
Power source	AC
System Software & Processors	
Software characteristics	OCR/ANPR matching of front plate image
Matching approach	N/A
Location of processor	OCR processor is located at the roadside (alarmed to prevent tampering). Central processor is located in South Melbourne
System hardware	PC
Clock synchronisation	GPS units at each site used to ensure all clocks are synchronised to a common time source; secondary measurement system currently being installed incorporates alternative GPS time source
Size and type of image data file	Approx. 1MB/Redflex proprietary INC format. Data is encrypted
Data storage approach	Data is retained for 7 days before deletion at the roadside processor
Communications Network & Back Office	
Communication network approach	Fixed line, Telstra BDSL
Data sent to back office	Data for all vehicles are sent to back-office. Data is encrypted at the source prior to communication to the back-office. The vehicle image and data block are rasterized into a new JPEG image
Data included on data block	Time, date, location, direction, lane, offence type, speed zone, vehicle speed, device type, device serial number
Degree of back-office automation	All incident records are checked and processed by human verifiers. Process involves two moderators – in case of a disagreement, a third moderator is used

By operational standards, the system is overt and the use of fixed signs to advise motorists of the enforcement network is an operational policy rather than a legislative requirement. Furthermore, the signs do not specify the measurement of average speed, but rather inform motorists of the operational use of road safety cameras in the area.

The system involves an unpublished discretionary enforcement threshold that is comparable to tolerances enacted for other automated speed enforcement in Victoria.

The accuracy of the system with regard to plate matching and identification is reported to be high. Less than 5% of plates are reported to be unreadable, with high rates of accuracy also reported for interstate number plates. Working group discussions revealed that approximately 300 different number plate style variations are currently available within Victoria. As such, before any new plate can be released onto the market, it is tested to ensure readability by automated speed detection devices, OCR/ANPR detection systems and other road safety camera and tolling equipment.

Data collected from the system is also used to perform unregistered vehicle registration checks; however, this process is only conducted on vehicles detected exceeding the speed limit. While Redflex is responsible for maintaining the system (e.g., central processing unit and cameras), they have no access to vehicle registration or driver data obtained by the system (Cameron, 2008). The Traffic Camera Office (TCO) within the Victorian Police must validate and authorise all infringement notices. Tenix are responsible for the administration of infringement notices, which are disseminated five days after the offence to ensure that maintenance checks are appropriately carried out and that the system is operating accurately and reliably. Such maintenance checks (e.g., in-road sensors and time interval measurements) are conducted regularly and tested by independent testers. Indeed, maintenance checks and testing are performed on various components of the system on a daily, monthly or quarterly basis.

5.1.1.4 Legislative characteristics

The point-to-point speed enforcement system employed in Victoria is legislated under the *Road Safety Act 1986 and Road Safety (General) Regulations 2010*. The specific provisions under the Act pertaining to point-to-point include:

- Prescribed speed measuring device
- Definition of data
- Process of production of printed image
- Prescribed process
- Average speed evidence of actual speed
- Evidence of road distance.

The speed measuring device (also known as a speed calculation unit) must be tested and sealed in the prescribed manner as mandated by the regulations, a process by which a certificate is issued upon successful completion. Definition of average speed data involves the time in which a vehicle passed both the first and second enforcement locations, the shortest possible distance between the two points and calculation of average speed in accordance with the Act. The process of the production of a printed image involves a certificate outlining the use of a tested and sealed device in a prescribed manner, with regulations and sections of the Act specifying how an image of the offending vehicle and details of the date, time and location of the offence can be included on such certificates. Currently however, images are not included on infringement notices, although there are considerations to make images available online. Infringement images are currently made available to the public through either viewing the images in person or having a copy of the images mailed to the infringement notice recipient.

The prescribed process allows the creation and use of a digital file, and subsequent analysis and possible issuing of an infringement notice, based on the calculation of the average speed of a vehicle identified from data from two or more detection devices. The Act also allows for average speed to be calculated, using the formula, shortest possible distance between two enforcement points divided by the time the vehicle took to travel between the two points, as admissible and prime facie evidence of the actual speed of the vehicle. A recent October 2010 amendment to the legislation has allowed the time to be, expressed in part of seconds, that has elapsed between the motor vehicle or trailer passing the first and second points. Prior to this amendment the time was expressed in whole seconds. Finally, a certificate must be issued by an independent licensed surveyor identifying the shortest possible distance (in metres) between the two enforcement points.

Given that the system involves contiguous camera sites, a multiple infringement policy is in place. Specifically, this policy pertains to offences within 10km/h over the posted speed limit along the length of the point-to-point network, such that if a driver is identified as having committed multiple offences within this network in a single journey, only a single infringement is issued for point-to-point. If offences committed exceed 10km/h over the speed limit, the offending driver will be issued with multiple infringement notices. As with all Australian jurisdictions, onus of responsibility is on the owner to nominate the driver of the vehicle.

Following the system software fault occurring in October 2010 (see Section 5.1.1.1), all new point-to-point speed enforcement systems implemented in Victoria will be required to include an independent secondary speed measurement and GPS system. Similar such systems are currently employed in relation to all other fixed road safety cameras used in the State and thus such a move represents a standardisation of policies and practices across all fixed road safety enforcement systems.

5.1.1.5 Broader issues

Broader speed management issues: One of the important features of the Victorian point-to-point system is the manner in which it fits within the overall speed management strategy for the jurisdiction. Specifically, the end-to-end infringement process is the primary responsibility of the Infringement Management and Enforcement Services (IMES), a section of the Department of Justice (DOJ). IMES, which has been in place for approximately five years, has a number of core functions including:

- Policy development and implementation (involves representatives from DOJ, VicRoads and Victoria Police)
- Contract management (including the outsourcing of infringement processing)
- Delivering and monitoring the road safety camera program
- Enforcement of unpaid infringement penalties through the Infringements Court
- Enforcement of warrants by Sheriff's Officers, issued by the courts
- Enforcement services relating to the confiscation scheme through Asset Confiscation Operations (ACO).

While the Victorian Police are removed from the maintenance and management processes related to the point-to-point speed enforcement system, they maintain an important role as the authorising body of all infringements.

Given the extensive number of organisations involved in the speed management process in Victoria, there is not surprisingly a great deal of information sharing occurring. However, it was reported that there is a need for this process to be formalised to enhance the efficiency of the overall process.

The Auditor-General conducted an investigation into the road safety camera program in Victoria (Victorian Auditor-General's Office, 2011). The report concluded that road safety cameras in Victoria: use a sound rationale; are sited and deployed according to appropriate road safety outcomes which could be strengthened via random deployment of mobile cameras; and have processes and controls in place which provide high levels of confidence in the system’s reliability and integrity. Additionally, the report highlighted that generating revenue is demonstrably not the primary purpose of road safety cameras and that more could be done to address public misconceptions about camera programs and to promote their positive contribution of road safety in Victoria.

Broader road safety issues: Historically, the original concept of point-to-point speed enforcement in Victoria was, like New South Wales, focused primarily on heavy vehicles. However, from commencement of point-to-point the use of the technology extended to all vehicle types.

It was acknowledged that point-to-point enforcement, while promising, will not fix all road safety problems at the enforced section of road, and that a potential lack of public and political support are recognised as real and important considerations. Indeed, it was noted that Victoria has experienced negative feedback when enforcement efforts are successful (e.g., when vehicle speeds are reduced), such that the continued need for enforcement or cost-effectiveness of the system is questioned.

The view was expressed that that national licence and registration databases need to be improved to facilitate enhanced system efficiency.

Public education: General education regarding road safety, and more particularly speed enforcement, is conducted by the Transport Accident Commission (TAC). At the time of writing, there were no specific public education or awareness campaigns regarding the use of point-to-point speed enforcement systems. At the initial implementation of the point-to-point system back in 2007, Variable (electronic) Message Signs were employed to inform motorists of the approach. DOJ also regularly issues media releases about enforcement activities, including point-to-point, and also use their website (www.camerassavelives.vic.gov.au) as an information tool and communication portal to the public.

In addition, the stakeholders reported the need for a strategic communications plan to be developed and the need to attempt more proactive approaches to dealing with the media.

Evaluation: To date, no formal evaluations of the Victorian point-to-point speed camera system have been conducted.

5.1.2 Queensland

5.1.2.1 Extent of use of point-to-point speed enforcement

Queensland is currently in the process of conducting a proof-of-concept phase of point-to-point enforcement, where it is being tested to correct functionality and ensure it is integrated into a new Queensland Police Service back office prior to use for enforcement purposes. The proof-of-concept phase represents the first installation of the technology for the purposes of speed enforcement in the state. The phase site, located on the two-lane Bruce Highway (northbound) between Glass House Mountains and Caloundra, is 14.7 kilometres (see Table 5.3). The speed limit throughout the section remains constant at 110 km/h. The location was selected based primarily on crash history; however access and egress opportunities, access to power sources and the proximity of the location to the Brisbane area for ease of managing the testing phase were also considerations for site selection. Exclusion of the southbound lanes was predominantly due to a separate trial of chevrons (e.g., lane markings) to encourage safe following distances and the potential confounding effects on trial data. In addition, working group discussions revealed that funding has been allocated for a second system.

Table 5.3: . Location and characteristics of point-to-point speed enforcement systems in Queensland.

Location	Length of enforced section	Status of system	Speed limit
M1 – Bruce Highway (Coochin Creek to Caloundra)	14.7 km	Proof-of-concept phase	110 km/h

It was reported that there was no future intention to implement point-to-point speed enforcement systems on sections of road that did not have a constant single speed limit throughout the entire section. The primary justification for such a policy was to reduce public confusion. However, there was a suggestion that future implementations of the technology could include systems involving contiguous enforcement corridors, particularly on more rural stretches of highway. While the use of point-to-point speed enforcement in urban areas was not completely ruled out, there was a preference reported for the use of mobile speed cameras for speed management on urban roads. However locations where mobile speed cameras may not be able to be used including tunnels and motorways (where variable speed limit are used) could be considered for point to point locations.

5.1.2.2 Technological characteristics

A detailed overview of the technological characteristics of the Queensland point-to-point speed enforcement system used in the proof-of-concept phase is provided in Table 5.4. The system, which is similar to Victoria's system, was provided by Redflex and involves rearward facing cameras. Both lanes of northbound traffic on the highway are monitored, each by a designated camera. The system involves a plate camera for each lane, as well as a scene camera that covers both lanes. The cameras and infra-red flash are mounted on separate roadside poles.

The cameras are triggered by in-road sensors imbedded under the road surface. The systems are capable of both instantaneous speed and average speed measurements. The system experiences some issues regarding identifying unfamiliar (e.g., interstate or personalised) number plates and dirty and damaged number plates.

No issues associated with vandalism or tampering were reported, however the system includes alarms to warn of potential attempts.

5.1.2.3 Operational characteristics

All aspects of the Queensland point-to-point system are managed and operated by organisations affiliated with the jurisdictional government (e.g., Police or Transport Authority), with no outsourcing of responsibilities to private organisations. Queensland Police will be responsible for the administration of offences should the system become enforceable.

Two signs are currently used in association with the system. The first sign reads ‘Speed Cameras Next 15 kms for Road Safety’, and is installed on the approach to the first camera in the system. The second sign reads ‘Speed Camera for Road Safety’, and is installed on the approach to the last camera in the system. The signs also contain a pictogram of a camera. Signage was installed during the latter period of the testing phase. The signage represents a policy requirement, with no legislative requirement for the system to be signed. The decision to use the specific message contained within the signs took into consideration the systems capability to measure both average and instantaneous speeds.

Stakeholders suggested that calibration of the system would occur annually, with renewed certificates presented to certify the accuracy of the equipment. Moreover, similar to other types of speed measuring devices, point-to-point systems will be validated every six months (not mandated), with equipment to also undergo regular testing procedures (as frequently as multiple times per week). Checks of the clock synchronisation would also occur as part of this calibration process. In addition, the clocks synchronise every 30 seconds using GPS and network time protocol (NTP) technology, with a log of the drift in relation to the time sync logged at 30 minute intervals. Data are quarantined if drift is found to exceed certain levels.

The Queensland system will also involve an unpublished enforcement tolerance which will most likely be identical to the tolerance enacted for other automated speed enforcement in the state. The primary justification for non-disclosure of the enforcement tolerance is to prevent the creation of a de facto speed limit amongst motorists.

Stakeholder consultations also revealed a desire to use the point-to-point system for additional purposes other than speed enforcement. Specifically, the potential for the system to be used for the identification of unregistered and uninsured vehicles was reported, however discussions were required to decide whether all vehicles passing the cameras, or just those detected exceeding the speed limit, would be monitored for these purposes. Such decisions were likely to be highly dependent on system requirements and capabilities.

5.1.2.4 Legislative characteristics

While no legislative changes were required prior to the proof-of-concept testing phase of the Queensland system, given the fact that it is operating in a non-enforceable manner, some legislative changes are currently tabled in anticipation of further developments of the system. The point-to-point speed enforcement system employed in Queensland is legislated under the *Transport Operations (Road Use Management) Act 1995*, and more specifically Part 7 – Section 112 to 120A and *Traffic Regulation 1962,* Part 22. The specific provisions under the Acts pertaining to point-to-point include:

- Prescribed speed measuring device
- Average speed evidence of actual speed
- Evidentiary provisions
- Prescribed process
- Evidence of road distance.

Table 5.4: Technological overview of point-to-point speed enforcement systems in Queensland.

System Component	Specific Characteristics
Cameras & Illumination	
Number of cameras	9 – at each camera site there are 2 plate cameras (one for each lane) and 1 scene camera that covers both lanes
Number of camera sites	3 camera sites – 2 entry sites (one on highway, one on exit/entry ramp), 1 exit site
Camera resolution	Plate – 2 megapixel; scene – 11 megapixel (small exposure and trigger times reduces overall quality however)
Digital or analogue	Digital
Monochrome or colour	Colourised infrared
Camera activation	In-road sensor
Forward or rearward facing	Rearward
Camera per lane or multiple lanes	Designated plate camera for each lane; scene camera covers both lanes
Illumination approach	Infrared
Infrastructure	
Camera mounting approach	Pole mounted to side of road. One pole mounts the camera, another is used to mount the flash and a third is used to mount the communication equipment (southern site only)
Purpose built or existing	Purpose built. Guardrails were also constructed to protect vehicles from hitting the poles should they crash at the site. Power enclosures also constructed at the site
Camera housing approach	Standalone enclosure (stainless steel)
Power source	AC – 240V single phase
System Software & Processors	
Software characteristics	OCR/ANPR
Matching approach	Combination of template matching, structural analysis and neural networks
Location of processor	Roadside and central processor at back-office
System hardware	Small industrial PC running Windows XP Pro
Clock synchronisation	Synchronised to common time source
Size and type of image data file	Plate image = 800kB; data block is a text file that is rasterized over the plate image to form new JPEG image
Data storage approach	Data (images, metadata) initially stored at roadside server, with data for non-offending vehicles deleted and offence data for offending vehicles sent to central processor at back-office
Communications Network & Back Office	
Communication network approach	3G (remote site)/Ethernet (local)
Data sent to back office	Only data on offending vehicles sent to back-office. Data are encrypted and transmitted through private networks
Data included on data block	Date and time, lane position, speed limit, location, direction, device type and serial number (elapsed time and capture speed added later)
Degree of back-office automation	Highly automated but manual checks for plate verification and unregistered/unlicensed vehicles

The speed measuring device must be an approved device and comply with the appropriate Australian Standards or manufacturer's specifications and be accompanied with appropriate certification. The regulations outline how to operate and test the device, as well as what information must be in the data block. The Act identifies the formula for calculating average speed across the shortest possible distance between two enforcement points, as admissible and prime facie evidence of the actual speed of the vehicle, as well as evidentiary specifications for an image and certification and calibration requirements for a device.

In Queensland, the shortest possible distance between two points on a section of road is measured using the edge line to signify what constitutes the road (e.g., does not include the road shoulder). A certificate must be issued by an independent surveyor identifying the shortest possible distance (in metres) between the two enforcement points, with the surveyor and measurement approach adopted appropriately certified also. The issue associated with re-surveying the road section in instances of roadworks was also highlighted.

The prescribed process allows an infringement notice to be issued based on the calculation of the average speed of a vehicle identified from data from two or more detection devices. As with all Australian jurisdictions, onus of responsibility is on the owner to nominate the driver of the vehicle.

There is a requirement for the data on which an offence is based to be 'traceable', such that measurement of time and speed are in line with national standards regarding what constitutes a single unit of time (e.g., second/minute) or length (e.g., metre/kilometre).

While it was reported that the measurement approach for point-to-point speed enforcement is not dissimilar to that employed by fixed or mobile cameras (which measure vehicle speeds between two much closer points), changes to legislation represent a clearer and less confusing approach, particularly for the public.

Should the system become enforceable, a multiple infringement policy will also need to be enacted, given the capability for the system to measure both average and instantaneous speeds. While concrete decisions are yet to be made, such a policy is likely to enforce only the most serious of offences, with average speed offences argued to be more serious compared to instantaneous speed offences of a similar degree over the speed limit.

Given that point-to-point systems, by their very nature, also collect data on vehicles which have not committed an offence, it was reported that particular provisions must be made to ensure the security of data collected by the system and restrictions on access to such data. Currently, non-offence data are deleted by the system after 24 hours. In addition, the absence of forward-facing cameras negates issues associated with the identification of non-offending motorists and passengers.

5.1.2.5 Broader issues

Broader speed management issues: While point-to-point is perceived to be an innovative and promising new approach to speed enforcement, stakeholder consultations revealed that the mobile speed camera program will likely remain the predominant speed enforcement approach in Queensland (including an increase in operating hours and increased covert operation), followed by point-to-point cameras, red light/speed cameras and fixed cameras. The use of point-to-point speed camera systems was argued to be particularly beneficial for heavily trafficked roads with high crash rates, particularly in rural areas where other approaches to speed enforcement are more difficult to conduct. In addition, traffic management (such as the current use of a system to monitor heavy vehicles on the urban corridor) is an anticipated use of point-to-point systems.

Indeed, a business case is currently being developed proposing the expansion of the use of speed cameras, including point-to-point. While further use of point-to-point systems is obviously dependent on the results of the trial and discussions with local government, other recent shifts in the speed management strategy in Queensland include the introduction of covert mobile speed cameras, additional fixed speed cameras and the testing of combined red-light/speed cameras.

Overall, point-to-point speed enforcement systems are not anticipated to generate significant degrees of revenue from fines, given that the systems are typically associated with relatively low offence rates. Instead, Queensland stakeholders suggested that the cost benefits associated with the approach are likely to be achieved through a reduction in vehicle speeds and a subsequent reduction in traffic crashes, which would, in turn produce a reduction in social and other costs associated with road trauma.

One of the fundamental advantages of point-to-point speed cameras noted was the extended impact on behaviour. Specifically, it was suggested that point-to-point enforcement reduces the halo effects associated with other automated speed enforcement approaches. However, it was suggested that the approach could still produce halo effects, simply surrounding a longer section of road rather than a single point.

Broader road safety issues: Stakeholders reported a greater need for national cooperation with respect to equipment and data collected from point-to-point systems. Specifically, there were suggestions for common platforms to facilitate greater communication of information between jurisdictions, such as consistency in time synchronisation approaches.

Public education: During the initial phase of implementation of the system, steps were taken to ensure information was readily available to the public regarding how the technology operates and the specifics of the proof-of-concept phase[22]. Nonetheless, the stakeholders reported a general deterrent effect associated with the proof-of-concept phase, such that many motorists perceived the system to be operational in an enforcement capacity. It was reported that another wave of public education (e.g., web-based fact sheets, media releases, and appropriate paid media) would be conducted upon the system becoming enforceable. The likely focus of such awareness materials was reported to be an explanation of how the technology operates.

Evaluation: An evaluation of the proof-of-concept phase is proposed and will address the performance of the point-to-point system in isolation, as well as in relation to the overall speed camera program. While pre-implementation data relating to speed and crashes along the enforced section has been collected, it was highlighted that it would likely be a number of years before sufficient post-implementation data would be available to conduct a rigorous evaluation.

5.1.3 New South Wales

5.1.3.1 Extent of use of point-to-point speed enforcement

Currently, New South Wales is installing a total of 21 bi-directional lengths of road enforced by point-to-point speed camera systems with the roll out of these lengths expected to be completed in 2012. The technology is used to monitor heavy vehicle speeds only, and the routes (outlined in Table 5.5) were designed to cover most popular heavy vehicle routes in the state. The length of the enforced sections ranges from six kilometres to 75 kilometres in

[22] This was achieved through media releases and information provided on appropriate Government websites.

length and the enforced stretches have minimal opportunities for access and egress, particularly near the actual site of the camera, to avoid vehicles circumventing the system. A number of the systems involve multiple speed limit sections within the enforced corridor. While the systems have the capacity for multi-point detection, deployment for such purposes is not currently conducted.

Table 5.5: Location and characteristics of point-to-point speed enforcement systems in New South Wales (as at February 2010).

No.[a]	Road	Section	Length (kms)
1	Mount Ousley Road	Between Picton Road and Gwynneville	6
2	Great Western Highway	Between Raglan and Meadow Flat	27
3	Hume Highway	Between Coolac and Gundagai	20
4	Hume Highway	Between Yass and Coolac	75
5	Mid Western Highway	Between Bathurst and Blayney	35
6	Monaro Highway	Between Bredbo and Cooma	34
7	New England Highway	Between Muswellbrook and Aberdeen	11
8	New England Highway	Between Singleton and Muswellbrook	46
9	Newell Highway	Between Eumungerie and Gilgandra	27
10	Newell Highway	Between Peak Hill and Tomingley	17
11	Pacific Highway	Between Kew and Port Macquarie turn off	21
12	Pacific Highway	Between Nabiac and Taree	24
13	Pacific Highway	Between Port Macquarie turn off and Kempsey	40
14	Pacific Highway	Between Harwood and New Italy	35
15	Federal Highway	Between south of Hume Highway and Collector	20
16	Pacific Highway	Between Woodburn and Wardell	20
17	Mitchell Highway	Between Molong and Condumbul	28
18	Golden Highway	Between Sandy Hollow and Merriwa	34
19	Gwydir Highway	Between Glen Innes and Inverell	60
20	Oxley Highway	Between Gunnedah and Tamworth	60
21	Picton Road	Between Mt Kiera Rd and Macarthur Dr	16

a. These numbers provide a reference only and do not represent the priority or planned roll-out of P2P lengths.
Source: Roads and Traffic Authority (2010).

Specifically, the technology is used to monitor heavy vehicle speeds. The detection of heavy vehicles is restricted to those vehicles registered above 4.5GVM and this is reflected in the current legislation allowing for the use of point to point in New South Wales. A number of political and historical reasons for the focus on heavy vehicles were noted. At present, there is no intention to use the technology on urban corridors because of the heavy vehicle focus.

Sites were selected by the New South Wales Centre for Road Safety. The primary criterion for site selection was evidence of problems associated with heavy vehicle speeding and associated crashes. The program targets common freight routes, particularly in rural areas. When deciding on the specific location of the gantries to which cameras are affixed, a number of factors are considered, including chicane avoidance minimisation; the environmental impact of the installations; heritage and Aboriginal land rights concerns; ease of obtaining power supply; council and residential consultations; and geotechnical studies.

Previous installations of point-to-point speed cameras have been trialled as a speed management approach for all vehicles. In 2005, technological feasibility trials (e.g., no enforcement activity, no public education) were conducted at three sites. The first was the Great Western Highway (M4) between Wentworthville and Granville in western Sydney, near Parramatta, and involved a 4.2 kilometre stretch of 90 km/h road with three lanes. The other two sites were located on the Pacific Highway, including a 35 kilometre stretch from New Italy to Harwood and a 12 kilometre stretch near Chinderah. The trials focused on the reliability of the systems to monitor traffic of differing volumes. Redflex was contracted to supply the technological systems, although the technology used differs to what is used now in the live sites. The three sites were chosen due to identification as high-speed risk zones. During the trial, no infringement notices were issued to motorists whose average speeds were found to have exceeded the speed limit. Instead, motorists received a letter from the RMS warning them their speeding had been recorded.

5.1.3.2 Technological characteristics

The technical design of the New South Wales point-to-point systems was split into various components. The systems primarily involve cameras mounted on overhead gantries. All gantry installations are purpose built and included the following considerations:

- Fabrication of footing cages and structure
- Galvanising of structure
- Installation of footings bolts and conduits (concrete pour)
- Installation of structure and road-side cabinets
- Installation of guardrail and hardstand area for operator entry parking and exit
- Installation of power to the site
- Installation of communications
- Installation of sensors and possible re-sheeting
- Installation of cameras, flashes and associated equipment/security.

The specific number of cameras in a particular system is proportional to the number of lanes and directions to be enforced, with one camera per lane/per direction (e.g., two cameras in one lane if bi-directional). A number of systems also include a camera for the purpose of monitoring the emergency/breakdown lane. The systems only have the capability of measuring average speeds at each camera site. As can be seen in Table 5.5, a number of enforcement corridors involve long distances. The stakeholders noted that issues may be experienced given that none of the systems involve contiguous enforcement corridors.

Induction loops in the road surface are used to activate the cameras, based on higher detection rate capabilities, although it was noted that radar activation was used in earlier trials. Given that the systems only monitor heavy vehicles, the systems also identify vehicle type. A GPS clock developed by Telstra is used by the system to synchronise the clocks every three minutes, with a log of the amount of correction recorded.

The stakeholders reported that the ANPR software has approximately an 80-90% accuracy rate. As such, manual checks of all matched incidents are performed.

A detailed overview of the technological characteristics of the point-to-point enforcement systems operated in New South Wales is provided in Table 5.6.

5.1.3.3 Operational characteristics

In an attempt to make the system more coordinated, Transport for NSW is responsible for policy decisions with the management and operation of the point-to-point systems and for databases associated with the system carried out by Roads and Maritime Services. The State Debt Recovery Office (SDRO), part of the Treasury, is responsible for the administration of the infringements. The infringement process is integrated with existing enforcement systems to allow for greater coordination.

The stakeholders outlined a number of operational considerations associated with point-to-point enforcement systems in the state. These included:

- The management of roadworks or modifications within the enforcement length and the subsequent impact on surveyed distance
- Conducting additional police enforcement within the sites
- The focus on heavy vehicles only.

Some alternative approaches that may assist in addressing these issues include creating smaller enforcement lengths or using contiguous enforcement corridors, monitoring all vehicles, using a single supplier to minimise complexity, improved national standards in plate consistency and reduced interstate duplications and interstate databases.

The systems are clearly marked with road-side signage to warn motorists of the enforcement efforts. An average speed enforcement sign is required within 150 metres of the camera, within the detection zone. Specifically, the signs include the text: ‘Average Speed Safety Camera’ on the approach to the cameras. The term ‘average speed’ is used due to legislative requirements. No specification is made within the signs to suggest the enforcement is restricted to heavy vehicles only and there is no repetition of signage throughout the enforcement corridor. Other penalties apply to avoidant behaviours within the enforcement corridor.

During the development and implementation of the point-to-point systems, forethought ensured ready access to the system components to allow maintenance to occur without causing significant disruptions to traffic (e.g., no road closures). As will be discussed below, legislation requires that all average speed detection systems are tested every 30 days by trained and approved personnel, surveyors and operators, with much of this testing performed remotely, given the high number of rural sites.

A program was started to check for unregistered vehicles, however there were issues regarding the types of offenders being detected. Specifically, many offenders had not realised that their vehicle was no longer registered and did not represent motorists wilfully and deliberately breaking the law. Thus, while the systems are capable of being used for other enforcement activities they are not currently employed for such purposes. Data collected by the systems is stored on-site for a week, with only information on offending vehicles retained. It was noted that internal departmental privacy experts had assessed privacy considerations and that such privacy issues would be revisited if the systems were to be extended beyond the enforcement of heavy vehicles only.

Table 5.6: Technological overview of point-to-point speed enforcement systems in New South Wales.

System Component	Specific Characteristics
Cameras & Illumination	
Number of cameras	Proportional to number of lanes and directions to be enforced – 1 camera per lane/per direction
Number of camera sites	2 camera sites (entry/exit) - no contiguous enforcement corridors
Camera resolution	Medium
Digital or analogue	Digital
Monochrome or colour	Hybrid – infrared at night (monochrome) and colour during the day
Camera activation	Induction loops
Forward or rearward facing	Primarily forward facing
Camera per lane or multiple lanes	Camera per lane
Illumination approach	Infrared
Infrastructure	
Camera mounting approach	All systems fixed to overhead gantries
Purpose built or existing	Purpose built
Camera housing approach	Specification issued includes requirements for weather protection, as well as ballistics and vandalism resistance
Power source	AC
System Software & Processors	
Software characteristics	Camera supplier specific - Varies according to the manufacturer
Matching approach	Varies according to the manufacturer
Location of processor	Camera computer or roadside processor - Varies according to the manufacturer
System hardware	Small industrial or custom PCs with the appropriate thermal operation parameters
Clock synchronisation	GPS
Size and type of image data file	JPEG. Average = 250kB; some suppliers have lower sizes. Image data size is proportional to resolution - Varies according to the manufacturer
Data storage approach	All images collected are encrypted and stored at the location (camera or roadside processor). Data on offending vehicles retrieved by central server and stored as potential offence file. Data on non-offending vehicles overwritten at agreed storage interval
Communications Network & Back Office	
Communication network approach	Highest bandwidth available - ADSL or 3G. 3G used for remote locations
Data sent to back office	Only data on offending vehicles
Data included on data block	Time, date, site number, description of the location, operator or recent system inspector – data block is rasterized onto vehicle image JPEG to create new JPEG
Degree of back-office automation	Human checks of all matched incidents are performed

5.1.3.4 Legislative characteristics

In 2010, amendments were made to the *Road Transport (Safety and Traffic Management) Acts* and *Regulations 1999 No. 20*, such that Section 43A states that average speed is evidence of actual speed in certain circumstances, with the precise formulas for how average speed and average speed limits are calculated defined and certified. Specifically, legislation allows for evidence of a vehicle's average speed to prove a speeding offence under existing laws in New South Wales. A number of certificates are required for the system. These include:

- Certificate of shortest possible distance – defines the shortest surveyed distance between the two camera sites accounting for corners, hills, etc. This certificate must be done annually
- Average speed certificate – defines the exact formula for calculating average speed. This certificate must be done annually
- Certification of device (Section 47A) – gazetted and type approved as an average speed device. This certificate must be done annually.

In addition, as outlined above, legislation in New South Wales requires monthly testing of point-to-point speed enforcement devices, with a certificate of testing required for court-related matters. Increased penalties were also introduced for avoiding the cameras. As in other Australian jurisdictions, the onus of responsibility for camera detected offences is with the vehicle owner.

While there are no systems with contiguous enforcement corridors or instantaneous speed cameras, the issue of additional police enforcement within these sites provides a challenge regarding dual infringement management. Specifically, active policing in the enforcement corridors is encouraged. Typically, weight is given to the more serious offence when multiple offences are detected within the enforced section. Another consideration is 'two-up driving', whereby individuals claim they switched drivers during the enforcement corridor. Legislation exists whereby both alleged drivers are able to be prosecuted.

5.1.3.5 Broader issues

Broader speed management issues: Mobile and fixed speed cameras are also employed in New South Wales, specifically at black-spots. The use of fixed digital cameras has been successful in reducing speeds at black-spots but general speed suppression is needed across the entire road network and stakeholders argued that point-to-point can assist with this goal. It was reported that recent data comparing the locations of fatal crashes from one year to the next only revealed an 11% overlap of locations. Therefore, it was argued that fixed cameras will only have limited impact on these crash locations in terms of overall deaths.

Stakeholders suggested that point-to-point systems are appropriate for the specific treatment of longer sections of dangerous roads (e.g., poor crash history, evidence of speed-related problems). The approach is perceived to be more efficient than installation of multiple fixed cameras, however the effects of point-to-point are still perceived to be localised, with the area wherein the effect is achieved simply representing a larger area. Stakeholders acknowledged the potential for point-to-point to be utilised in urban corridors, suggesting that the infrastructure already largely existed through tolling booths and a roll-out of systems could therefore be achieved at a relatively lower expense. A number of advantages associated with point-to-point were noted. These included the high rates of compliance with prescribed speed limits and the subsequent reduction in the frequency of speed-related crashes. In addition, it was suggested that use of point-to-point can reduce the argument that speed enforcement is about revenue raising.

Stakeholders reported a desire for point-to-point to undergo further technological advancements in the future. In addition, they expressed a preference for point-to-point to be used to monitor all vehicles (not just heavy vehicles) and for the use of mobile systems to be explored, particularly for use in temporary road works zones. The implementation of point-to-point has been somewhat delayed by the roll-out of mobile, fixed and red-light/speed cameras in the state, as well as the installation of the gantries for the point-to-point systems.

Preliminary results from early trials of point-to-point in New South Wales revealed that the amount of speeding at the second camera was 1/50th of that at the first camera, which was an existing enforceable fixed camera. Compliance throughout the section was poor, reflecting that motorists were relatively unaware or the trial or perceived that speeding behaviour would not be punished (as the system was not enforceable). While the trials were intended only for heavy vehicles, data were collected for all vehicles, showing that heavy vehicles represented only 5% of those vehicles exceeding the speed limit in the section. This suggests that the use of the technology to monitor all vehicle types would have substantial road safety benefits.

The stakeholders argued that Australia is far from achieving best practice in point-to-point speed enforcement implementation, particularly because no Australian jurisdiction has rolled out the technology in an extensive fashion. In regard to other countries, the Netherlands was perceived as being closest to best practice. Potential risks associated with mismanagement of local council partnerships and heterogeneity in the rules and standards of operation relating to the use of point-to-point in the United Kingdom was highlighted, however it was noted that such practices have an advantage because they increase the input of local knowledge into the management of the process.

Broader road safety issues: In response to calls from some sections of the public and the media, an investigation of speed cameras was conducted by the State’s Auditor-General and findings were released in July 2011 (Auditor-General New South Wales, 2011a). The investigation sought to answer two questions: (1) Are speed cameras located where there was greatest road safety risk? and (2) Do speed cameras reduce speeding and crashes? Site selection criteria and performance of all fixed, mobile, and safety (red light/speed) cameras were investigated, though no specific mention was made of investigating the point-to-point systems for heavy vehicles in the report. The report concluded that overall, speed cameras do change behaviour, have had a positive road safety impact, and are generally located in areas with high road safety risk. However, it also noted that there may be alternative locations with greater road safety risk than those currently used and recommended that the Centre for Road Safety ‘develop an overarching strategy for speed cameras incorporating all camera types which includes criteria to determine the appropriate camera type of each road with a high safety risk’ (p. 3). Additionally, the report recommended that additional criteria for assessing camera effectiveness be considered, including reduced vehicle speeds which may include ‘changes in average and excessive vehicle speeds, or the number of infringements issued after installation’ (p. 23).

Stakeholders argued that more general signage (e.g., across the entire road network, even in locations where point-to-point is not used and without specifically highlighting that it only detects heavy vehicles) could increase the general deterrent impact of existing point-to-point systems. Indeed, it was argued that location-specific signage may produce only localised effects. In addition, the potential to use point-to-point systems to detect and enforce tailgating offences was highlighted; however this was noted to be associated with considerable technical difficulties.

Early trials highlighted that some heavy vehicles attempted to circumvent the cameras by driving on the wrong side of the road or in emergency lanes to avoid camera detection. In addition, some vehicles would stop inside the enforcement area. This presents an additional concern for relevant stakeholders in terms of general road safety.

Stakeholders argued that there needs to be a number of national priorities, including improvements in number plate consistency, database maintenance and reduced cross-jurisdictional duplicates of plates. It was suggested that the use of some other form of vehicle identification (e.g., electronic tags) may prove beneficial to achieving greater efficiency.

Public education: The stakeholders acknowledged that public education is critical for the overall speed enforcement message. Indeed, the use of point-to-point in New South Wales has been supported by an extensive public education and communication strategy focussed on explaining the technology and outlining the road safety benefits associated with the approach. This strategy includes online, radio, and other advertising components and not surprisingly is focused at heavy vehicles.

Evaluation: The stakeholders reported that they anticipated an evaluation would be conducted, with the New South Wales Centre for Road Safety to be consulted regarding the parameters of the evaluation. It was anticipated that a critical focus of the evaluation would relate to demonstrated compliance of all vehicles travelling between the points of the systems. Overall, they highlighted the need for better publication of enforcement evaluations and suggested that such a goal can only be achieved through a collective effort to make it the norm when implementing enforcement activities.

5.1.4 South Australia

5.1.4.1 Extent of use of point-to-point speed enforcement

South Australia currently has two point-to-point speed camera systems, both of which are currently undergoing user acceptance testing by the DPTI and are pending appropriate legislation to allow for the technology to be used for general enforcement purposes. The first system was installed on Port Wakefield Road, between Middle beach and Port Wakefield in early 2010. The system spans 51.5 kilometres of the 110 km/h rural dual carriageway north of Adelaide. The second site is located on Bridge Road in Pooraka, between Pratt and Priscilla Roads and spans 300 metres of the 60 km/h road. It must be noted that the Bridge Road site represents a research and development test site being utilised to assess different vendor systems and will not be used as an enforceable site. Table 5.7 outlines the location and characteristics of both sites. The locations were selected based primarily on crash history and reported problems of speeding along the sections of road, with the Port Wakefield system representing a specific safety initiative designed to address the road toll on rural roads, particularly associated with tourists.

Table 5.7: Location and characteristics of point-to-point speed enforcement systems in South Australia.

Location	Length of enforced section	Speed limit	Status of system
Port Wakefield Road – Middle Beach to Port Wakefield	51.5 km	110 km/h	Trial
Bridge Road, Pooraka – Pratt Road to Priscilla Road	300m	60 km/h	R&D[a]

a. Bridge Road is purely a research and development test site being utilised to assess different vendor systems and will not be used as an enforceable site.

5.1.4.2 Technological characteristics

A detailed overview of the technological characteristics of the South Australian point-to-point speed enforcement systems is provided in Table 5.8. The equipment is supplied by Aspect Traffic (Port Wakefield Road site) and Redflex (Pooraka site) and involves a number of similarities and differences. Both systems involve forward facing cameras, and therefore are incapable of detecting speeding motorcyclists. For the Port Wakefield system, a plate and scene camera is used for each designated lane of traffic, with the cameras and infra-red flash components mounted to purpose built overhead gantries and an offset infra-red illumination employed and a transportable infra-red traffic logger (TIRTL) activation system. Conversely, the Pooraka system employs a pole mounted approach on the side of the road, with a designated camera for each lane and loop detectors for camera activation. While the Pooraka system is capable of monitoring both average and instantaneous speeds, the Port Wakefield system is only capable of monitoring average vehicle speeds. Both are housed in specialised enclosures that protect them from weather conditions or vandalism. Issues with attempted vandalism or tampering were noted.

5.1.4.3 Operational characteristics

The operation and management of both systems in South Australia is wholly the responsibility of jurisdictional governmental agencies (e.g., Police, transport authority). As stated previously, neither system operates in an enforceable capacity; however DETI is responsible for infrastructure and validation, while SAPol would be responsible for adjudication, issuing infringements, funds collection and all prosecution matters, should the system become enforceable.

Mandatory maintenance systems are in place whereby systems are checked and cleaned every six months. Regarding synchronisation, the responsible authorities are currently still working on a suitable and accepted process. Like the previous states reviewed in this section, the shortest possible distance was assessed by an independent surveyor. Issues were reported regarding the ability of the systems to identify and read dirty, damaged or unfamiliar (e.g., interstate or personalised) number plates. Finally, data collected by the system is linked to licence and registration databases for owner identification.

During the working group it was reported that the use of point-to-point speed enforcement in South Australia will be accompanied by signage involving a camera pictogram and text reading 'Average Speed Safety Camera Ahead'. Prior to the trial system becoming enforceable, there are plans to display vehicle speeds on VMS mounted on a roadside trailer so that motorists are able to see their instantaneous speeds.

5.1.4.4 Legislative characteristics

Stakeholder consultations revealed that initial type approval and certification procedures are yet to be determined, but it was reported that all equipment must be tested and certified and be covered by appropriate legislation and regulations. This would include independent specification of the distance between camera sites, legislation regarding an average speed offence (currently exists for heavy vehicles but not for passenger vehicles), and the traceability of time synchronisation. In addition, legislation of a new average speed offence is currently being sought to give more flexibility for the use of point-to-point across non-discrete speed zones.

Decisions regarding multiple infringement policies, enforcement tolerances and signage requirements are also yet to be determined. However, it was reported that enforcement tolerances are unlikely to be different to those adopted for other approaches to automated speed enforcement. Specifically, it was reported that enforcement tolerances would be set by the Police Commissioner, with operational staff informed when the cameras became operational.

Finally, South Australia will adopt owner onus, with penalties applied to multiple drivers if nominated. All expiation notices will be sent to the registered owner in the first instance.

Table 5.8: Technological overview of point-to-point speed enforcement systems in South Australia.

System Component	Specific Characteristics
Cameras & Illumination	
Number of cameras	1 plate and 1 scene camera per lane of traffic (at both entry and exit points)
Number of camera sites	2 camera sites (entry/exit) – no contiguous enforcement corridors
Camera resolution	2 megapixel
Digital or analogue	Digital
Monochrome or colour	Monochrome
Camera activation	Port Wakefield site = TIRTL; Pooraka site = loop detectors
Forward or rearward facing	Forward
Camera per lane or multiple lanes	Designated camera for each lane
Illumination approach	Combination of Infra-red and continuous illumination
Infrastructure	
Camera mounting approach	Port Wakefield site = overhead gantry; Pooraka site = pole mounted to side of road
Purpose built or existing	Purpose built
Camera housing approach	Standard
Power source	AC, stepped down to DC
System Software & Processors	
Software characteristics	ANPR
Matching approach	Structural analysis
Location of processor	Roadside
System hardware	PIPS technology
Clock synchronisation	Still working on an accepted process
Size and type of image data file	TIFF – 128 bit
Data storage approach	Cached locally, uploaded on demand to central processor, data on offending vehicles sent to back-office only
Communications Network & Back Office	
Communication network approach	3G/Ethernet
Information captured by the system	Images (entry/exit), vehicle speed, date, time, location, lane, direction, plate number, confidence score
Degree of back-office automation	All images pertaining to detected offences are reviewed by humans

5.1.4.5 Broader issues

Broader speed management issues: Given that the use of point-to-point speed enforcement is still in trial phase, stakeholders were unable to comment on where the approach fits into the overall speed management strategy in South Australia. No comment was provided regarding the hypothesised or anticipated future role of the technology, suggesting this will be highly dependent on the outcomes of the trials currently being conducted.

Suggested benefits of point-to-point speed enforcement included the increased effects on speeding behaviour that could be achieved across a longer section of the road network, which was argued to be particularly relevant given the geography of the state (e.g., large proportion of rural roads). Indeed, the approach is perceived to be a particularly critical speed control strategy for use in rural and remote areas. However, the isolation of such installations, and the subsequent implications for servicing and maintenance of the systems was highlighted as a potential problem that needed to be addressed.

South Australia has operated point-to-point enforcement systems targeted at heavy vehicles, known as ‘Safe-T-Cam’ since mid-2004, as a method of monitoring heavy vehicle speeds and driver fatigue (Wiggins, 2006). Evidence from the Safe-T-Cam system investigating passenger vehicle speeds revealed that the sites were not suitably placed for light vehicles, thus resulting in the installation of the new site where there is limited access and egress between the sites and the posted speed limit remains constant throughout the enforcement corridor.

Public education: No public education strategies had been implemented at the time stakeholder consultations were conducted, however it was reported that such programs were perceived as very important. It was argued that public education should focus on the road safety benefits of the approach. In addition, it was suggested that a lack of public education can result in the increased prevalence of inappropriate challenges of infringements, subsequently increasing costs associated with the implementation of the system.

Evaluation: It was reported that the trial point-to-point systems would be evaluated; however minimal specifics were available at the time of the consultations.

5.1.5 Australian Capital Territory

5.1.5.1 Extent of use of point-to-point speed enforcement

In 2010 the Australian Capital Territory completed a Forward Design Study for the introduction of point-to-point speed camera systems. Procurement has been completed, with legislation passed in September 2011 to enable commencement of point-to-point camera operations in early 2012.

The first implementation of point-to-point in the Australian Capital Territory is planned on a 2.7 kilometre section of Hindmarsh Drive and is scheduled to be operational by late February 2012. A second site has also been selected but not yet formally announced (expected to be announced February 2012). The sites and characteristics of the locations involved in the final implementation plan are provided in Table 5.9. The proposed implementations of point-to-point speed enforcement in the Australian Capital Territory are planned for urban areas, a relatively unique situation in the Australian context.

Table 5.9: Location and characteristics of point-to-point speed enforcement systems in the Australian Capital Territory.

Location	Approx. length of section	Speed limit
Hindmarsh Drive: Tygarah Street to Mugga Lane	2.7 km	80 km/h
Second location determined but not yet formally announced		

The Forward Design Study considered a number of safety and traffic factors in considering possible sites. The safety factors included crash history and identified safety hazards, while the traffic factors included total traffic volumes, the extent of speeding and the suitability of the physical environment and infrastructure. Given that the Australian Capital Territory has a relatively good crash record, speed profiles were important in the selection of sites, such that reductions in vehicle speeds are assumed to produce road safety benefits.

5.1.5.2 Technological characteristics

A detailed overview of the technological characteristics of the point-to-point speed enforcement system to be implemented in the Australian Capital Territory is provided in Table 5.10. The equipment is to be supplied by Aspect Traffic. The system will involve rearward facing cameras, and therefore be capable of detecting speeding motorcyclists. A plate and scene camera is used for each designated lane of traffic, at both the entry and exit points (no contiguous enforcement corridors). The cameras and infra-red flash components will be mounted on purpose built side-mounted poles.

5.1.5.3 Operational characteristics

The system will be operated by the Australian Capital Territory Justice and Community Safety Directorate. The system supplier will be responsible for system development and provision of technical advice to allow export of data from the system in a suitable format for use by the Traffic Camera Office (TCO). The Justice and Community Safety Directorate (JACS – which the TCO is part of) will be responsible for system development to import this data into the TCO's adjudication system. TCO will then manage the system, the databases and the administration of infringement notices through the '*rego.act*' computer system.

The procurement process has included the establishment of a maintenance agreement with the system supplier covering agreed response times for different levels of incidents. This includes periodic maintenance following daily and fortnightly checks, and urgent reactive maintenance to respond to vandalism and similar events. Independent certification by a National Association of Testing Authorities (NATA) accredited agency is required on an annual basis, with internal Traffic Camera Office processes providing secondary certification on an ongoing basis.

It was noted that enforcement tolerances for camera detected offences is an Australian Capital Territory Policing policy responsibility. GPS time servers are used for clock synchronisation. A certified stopwatch is also used to provide independent accuracy testing of the system. Protocols are in place to quarantine images if malfunctions are detected. In addition, the Australian Capital Territory is working with the National Measurement Institute (NMI) to introduce secondary verification of P2P camera times by regularly checking the time on the P2P clock against the world atomic clock.

As noted in the Forward Design Study, a particular issue for the Australian Capital Territory will be the challenge of integrating point-to-point into an urban road environment on a network basis, as opposed to simply using it on single sections of road.

Table 5.10: Technological overview of point-to-point speed enforcement systems in the Australian Capital Territory.

System Component	Specific Characteristics
Cameras & Illumination	
Number of cameras	1 plate and 1 scene camera per lane of traffic
Number of camera sites	2 (entry/exit) – no contiguous enforcement corridors
Camera resolution	1280 x 512 pixels
Digital or analogue	Digital
Monochrome or colour	IR for number plate camera and monochrome for scene camera
Camera activation	Internal and/or external triggers
Forward or rearward facing	Rearward
Camera per lane or multiple lanes	Designated camera for each lane
Illumination approach	Infra-red pulsed LED
Infrastructure	
Camera mounting approach	Pole mounted in median strip
Purpose built or existing	Purpose built
Camera housing approach	IP68 housing purged with dry nitrogen
Power source	DC powered via switch mode mains power supply
System Software & Processors	
Software characteristics	Embedded Linux based ANPR engine and server
Matching approach	Structural analysis
Location of processor	Roadside cabinet
System hardware	Embedded solid state ANPR processor and server
Clock synchronisation	Stratum 1 GPS time server
Size and type of image data file	Encrypted container file with 3 JPEG images and XML meta-data. Typical size 450kB.
Data storage approach	Encrypted and cached locally, uploaded on demand to central processor. Images transferred for offending vehicles only
Communications Network & Back Office	
Communication network approach	3G/Ethernet
Information captured by the system	Images (entry/exit), date and time, location, lane, direction, GPS coordinates, site code, operator number
Degree of back-office automation	All images pertaining to detected offences to be adjudicated by humans

Based on tender specifications, the system will be designed to capture clear and detailed rear images of all vehicles irrespective of vehicle classification. The images captured will be of sufficient pixel resolution to enable a back-office system operator to determine the licence plate text, state of the licence plate, make and model of the vehicle and the lane in which the vehicle is travelling. The system will also be designed to automatically read and identify vehicle number plate information regardless of the position of the licence plate in the captured image, the style of the number plate (including reflective plates), if the image contains other alpha-numeric information unrelated to the number plate or if the image is captured in low-light conditions.

As noted above, the system will link to the TCO adjudication system and 'rego.act' computer system, which manages driver licensing, vehicle registration and parking and traffic infringement processing. Data for non-offending vehicles will be kept for 14 days and then automatically deleted.

5.1.5.4 Legislative characteristics

The Australian Capital Territory scheme for receiving and managing images from traffic cameras to generate infringement notices for traffic offences involves a range of provisions across the road transport legislation, including the *Road Transport (Safety and Traffic Management) Act 1999*, the *Road Transport (General) Act 1999*, the *Road Transport (Driver Licensing) Act 1999* and the *Road Transport (Vehicle Registration) Act 1999*, and the regulations made under those Acts. It is further supported by privacy legislation, administrative guidelines and policies, including policies relating to the handling of private information and complaints.

To accommodate the introduction of the point-to-point speed enforcement systems the road transport legislation, specifically the *Road Transport (Safety and Traffic Management) Act 1999* and *Road Transport (Safety and Traffic Management) Regulation 2000*, was amended to, among other matters:

- Enable evidence about the average speed of a vehicle between detection points to be used as evidence that a person committed a speeding offence
- Define the shortest distance between the detection points and the methodology used for calculating the average speed of the vehicle (including details of the formula for the calculation of average speed)
- Provide for evidentiary certificates relating to the operation of the average speed detection system
- Define the concept of an approved average speed detection device.

Processes have been put in place to provide for the distance between detection points to be surveyed by a registered and independent surveyor, who provides a survey report and certificate. In addition, maintenance schedules have also been finalised as part of the procurement process. Enforcement tolerances will be equivalent to other safety cameras operating in the Australian Capital Territory.

In the Australian Capital Territory, signage requirements are specified in the legislation. Specifically, Australian Capital Territory point-to-point systems have advance warning signs similar to those used in New South Wales, with a sign required not more than 100m before each detection point. In addition, mid-block repeater signage throughout the enforcement corridor is used.

The Australian Capital Territory already has a multiple infringement at one site policy that is applied to the combined speed and red-light cameras at intersections, such that offenders can be issued both a red light and a speeding infringement notice. However, the point-to-point system will issue notices for speeding offences only.

The onus of responsibility is on the owner of, or responsible person for, the vehicle to nominate the driver of the vehicle at the time the offence was committed.

Privacy issues have been raised by several parties during the development of Australian Capital Territory legislation for point-to-point speed cameras. As noted above, the Australian Capital Territory legislative framework includes the Privacy Act 1988 (Commonwealth) and the Information Privacy Principles under that Act. In terms of privacy implications, it is not possible to include personal information about the driver or vehicle owner on images taken by traffic cameras. The images show the rear of vehicles, focussing on the number plate region. The images do not show vehicle occupants or the areas next to roads.

Images from the cameras will be used for speed enforcement. The Australian Capital Territory point-to-point camera system is configured so that images from the system cannot be used for general or mass surveillance. Images are not live-streamed to police or other intelligence agencies, nor are they continuously monitored by the Traffic Camera Office as they are taken.

Under Australian Capital Territory legislation the purposes for which the images could be used must be authorised by law. Any future expansion in the use of images from the cameras would be subject to a privacy impact assessment and would need to comply with the Australian Capital Territory human rights framework. There is a future capacity for the system to identify images of vehicles on the RAPID hotlist if the system is interrogated by Australian Capital Territory Policing, but there has been no decision to implement this functionality.

5.1.5.5 Broader issues

Broader speed management issues: Current speed enforcement practices adopted in the Australian Capital Territory include police patrols using radar and laser speed measuring devices, mobile speed camera vans and fixed speed cameras. In line with the *Australian Capital Territory Road Safety Strategy and Action Plan*, it is intended that the Australian Capital Territory safety camera program will continue to be gradually expanded, with point-to-point speed cameras complementing the fixed and mobile cameras currently in place. The general objective, over time, was reported as achieving broad coverage on arterial roads by fixed and point-to-point speed camera systems, allowing the mobile cameras to focus on the non-arterial road network.

The primary advantage of point-to-point systems was reported to be the fact that the systems operate 24 hours a day, seven days a week, thus essentially making the likelihood of detection for speeding along enforced routes almost 100%. It was suggested that such a fact is expected to challenge the culture of speeding, improve speed compliance within the enforced area and reduce average speeds to the posted speed limit or below. As a result of these reductions in vehicle speeds, it is also anticipated that both the number and severity of crashes will also be reduced. The reported disadvantage of the systems involved the additional costs associated with the poles/gantry and the additional cameras at each site.

Public education: It was reported that the public would be informed about the introduction of point-to-point speed enforcement through media releases and other announcements. In addition, it was suggested that general speed awareness campaigns may also incorporate information about point-to-point camera systems at a later date. Based on experience with the current safety camera program (e.g., fixed and mobile speed cameras), the stakeholders noted that community consultation, advice and notification is essential prior to implementation of point-to-point speed enforcement. It was reported that educating the public may make them more aware of the role of point-to-point in speed management as opposed to just being ‘another revenue-raiser’ and may also allay any fears of privacy concerns and enhance public acceptance of the system.

Evaluation: Plans to evaluate the point-to-point speed enforcement systems following their implementation were reported, however the scope of these evaluations was yet to be determined.

5.1.6 Western Australia

5.1.6.1 Extent of use of point-to-point speed enforcement

Currently, Western Australia does not employ point-to-point camera systems for the purposes of speed enforcement. WA Police have just completed the final phase of the State Government's $30million enhanced speed enforcement program, which involves new speed and red light cameras, digital hand-held cameras and dual-lens digital cameras. Point-to-point cameras were not included in this program as it is intended to complete the existing program and bed it down before considering further expansion into new areas of technology.

It is considered that while the development and application of point-to-point technology is undergoing significant change in other jurisdictions, WA will maintain a watching brief and consider experience in these jurisdictions. However, research was commissioned by WA which was conducted by the Monash University Accident Research Centre (MUARC; Cameron, 2008) relating to point-to-point speed camera technology The results are discussed in more depth in Section 3.6.

The report suggested that point-to-point speed enforcement represented a cost-effective approach to managing speeds on metropolitan freeways, urban highways and dangerous stretches of rural highways (Cameron, 2008). Stakeholders reported a number of preferences regarding the use of the technology, including that the approach initially could be most efficiently used on sections of road between five and 25 kilometres in length with a constant speed limit.

5.1.6.2 Technological characteristics

The stakeholders revealed that they are yet to encounter a technological system which represents a mature enough approach to meet their requirements. It was argued that more research and development needs to be conducted in Australia to ensure that technological principles of best practice are not solely based on information collated from international experiences with point-to-point enforcement installations.

The stakeholders reported a number of preferences for the technological characteristics of the systems. Digital cameras providing colour images were preferred, with the specific resolution of the cameras dependent on what specifications returned the optimal plate images. Infra-red illumination was preferred to facilitate night-time use of the systems. It was suggested that the systems would involve both forward and rearward facing cameras, with a designated rearward facing plate camera for each lane (overhead mounted) and a single forward facing scene camera (pole mounted on side of road). To minimise infrastructure costs it was highlighted that bridges and existing structures/gantries could be utilised where possible. In addition to the measurement of average speeds, the stakeholders expressed a desire to also measure instantaneous speed.

A preference was expressed for the systems to be as non-invasive as possible. Thus, a preference was reported for laser activation of the cameras rather than induction loops, such that the road surface would not be disturbed. The location of the ANPR/OCR processor and software had not been determined and would likely depend on the requirements and capabilities of the system. Fibre optic communications networks were preferred, based on the robust nature of the approach and the capability for the approach to handle large amounts of data transmission. It was noted that if the fibre optic approach was too expensive or otherwise could not be achieved then wireless technologies could be utilised. It was also suggested that it may be useful to have a wireless back-up system. It was reported that the back-office would definitely involve human checks of all detected infringements.

5.1.6.3 Operational characteristics

The establishment of maintenance schedules were reported to be critical for the facilitation of public confidence in the credibility and reliability of the technology. While there are no legislative requirements in the state, policy requirements would likely mandate checks of the device and data on a monthly basis, with general maintenance (e.g., cleaning, signage checks) also conducted monthly.

It was reported that the use of contiguous camera sites would be considered, particularly on rural highways where there are increased opportunities for access and egress. In addition, stakeholders suggested that the enforcement tolerance, which is not publicly disclosed in the state, associated with point-to-point enforcement would depend on the accuracy of the device.

The stakeholders' reported issues regarding time synchronisation methods, and in particular a preference not to use GPS technology. Indeed, there was a desire to identify a more appropriate measurement system that holistically linked all cameras and systems (e.g., atomic clock). It was argued that whatever approach is adopted, it must also take into account the lag between the system and clock (e.g., time taken for information to travel along the communication cable).

While the stakeholders expressed a desire for the system to have the capability to collect data on non-offending vehicles for intelligence purposes (e.g., criminal activities), it was noted that most systems maximise their capacity when engaging in the speed enforcement tasks and thus have few system resources remaining for additional tasks. Moreover, the requirement of legislative support was also noted. It was reported that there would be a preference for data collected on offending images to be checked against a 'hotlist' of known vehicles, such as unregistered vehicles.

5.1.6.4 Legislative characteristics

A number of legislative changes were reported as being required prior to any implementation of point-to-point speed cameras in the state. These included gazetting of the device, the creation of an average speed offence and issues associated with the 'use' of enforcement devices. Specifically, any speed measurement device used in the state must undergo rigorous testing and is reported on regarding its reliability and accuracy. A report on the device must then be presented to government and gazetted by the Minister. Such approval then ensures that the data generated is prima facie evidence that an offence took place. In addition, it was noted that legislation changes would be required to enable enforcement of average speeds across single and varying (if desired) speed limits.

As in all Australian states, the onus of responsibility in relation to camera detected offences lies with the vehicles owner. Potential problems were highlighted regarding owner onus, such that individuals may claim to have swapped drivers during the enforcement corridor. It was noted that changes to legislation were currently attempting to address this issue.

The stakeholders reported that methods for the measurement of the surveyed distance between two points were currently being trialled. Specifically, certified surveyors were reported to be using measurement devices, tracked back to traceable measure, with accuracy down to a centimetre. In regards to multiple infringement policies, it was suggested that average speed offences would likely take priority over instantaneous speed offences given the extended nature of the offence; however instantaneous speed offences would be infringed where no average speed offence was detected.

While there are no legislative requirements regarding signage in the state, policy requirements would suggest that signs will be used. Specifically, signs would likely be identical to those used with fixed cameras and involve a pictogram of a camera. The exclusion of specific text was justified on the basis that the cameras will have the ability to measure both average and instantaneous speeds. It was reported that mid-block reminder signs would not be a likely characteristic of implementation given that they increase roadside clutter and maintenance.

While no privacy issues had yet been raised, the stakeholders reported that based on evidence from other Australian states, they did indeed anticipate issues to be raised at a later date. Specifically, they anticipated issues regarding the collection and storage of data of individuals who had not yet committed an offence. However, it was suggested that as long as protocols were in place in relation to the storage, use and timely deletion of such data, that these issues would not cause significant problems.

5.1.6.5 Broader issues

Broader speed management issues: Should point-to-point systems be considered for implementation in the future, the primary impetus behind such implementation was reported to be a desire to slow the traffic flow to the prescribed speed limit over a longer section of the road. That is, the halo effects associated with fixed and mobile approaches were noted. Stakeholders suggested that a major advantage of point-to-point was that it represented a fairer approach for motorists compared to other automated approaches given that speeds are measured over time rather than in one instance. The disadvantage of the approach was reported to be the additional costs and infrastructure required. However, it was noted that careful selection of enforcement sites to maximise returns through reduced social costs would negate these costs.

It should be noted that point to point enforcement is just one element recommended in a comprehensive strategy to address speed compliance across the entire network in Western Australia developed by MUARC in its report for WA to consider.

Broader road safety issues: A number of potential issues that could impact on road safety in general were noted; particularly attempts made from a minority of offenders to circumvent the technology (e.g., drive in the emergency lane, trucks travelling in convoys to block each other’s number plates). In addition, it was stressed that if point-to-point technology was introduced at some future point, police must continue to conduct other types of enforcement within the point-to-point corridor and not become complacent or ignore other offences that occur.

Public education: It was reported that, if a system was to be adopted, locations of point-to-point systems would be published on government websites, with information explaining the site selection process and how the technology works. However, it was noted that there would not be specific advertising or campaigns regarding point-to-point, and that dissemination of information would more likely occur through media releases. It was suggested that the fairness of the approach would not be emphasised as it may serve to undermine other approaches to speed enforcement.

Evaluation: It was reported that a comprehensive evaluation would be conducted if a point-to-point speed enforcement system was trialled. Such an evaluation process would likely include both an outcome evaluation and cost-benefit analysis. However, it was noted that the data required for crashes and cost-benefit analysis would take many years to collect. While speed and offence data would be available immediately, it was noted that offence rates typically increase substantially upon implementation of an innovative intervention and that such increases could be misconstrued by the media and public.

5.1.7 Tasmania

5.1.7.1 Extent of use of point-to-point speed enforcement

Tasmanian stakeholders are currently in the process of putting together a business case regarding the implementation of point-to-point speed enforcement in the state. It was noted that both light and heavy vehicles would be targeted for speed enforcement using the technology.

A number of preferences were expressed regarding site selection protocols. Mandatory factors included a constant speed limit throughout the entire length of an enforcement corridor and few (ideally none) opportunities for access and egress within the enforcement corridor or a lack of viable alternative routes to evade the system. Other important criteria for site selection included:

- Significant number of crashes, particularly fatal and serious injury crashes, along the length of road – not just a single 'black-spot' that could be appropriately addressed through the use of other treatments (such as fixed cameras)
- Speed profile suggesting speed along the entire route is a problem
- High traffic volume
- High proportion of heavy vehicle traffic
- No major foreseeable infrastructure changes planned for the section
- Proximity to mains power and fibre optic cabling
- Capacity for police/transport inspectors to intercept vehicles close to the site, if 'watch-list' functions are ever approved in the future for enforcement activities such as monitoring unregistered vehicles or unlicensed motorists.

It was reported that a minimum distance between camera sites of 300 metres and a maximum distance of tens of kilometres would be considered. It was argued that longer enforcement corridors would result in increased deterrent impacts, longer durations of compliance with prescribed speed limits and increased road safety outcomes and cost-benefits. It was noted that the approach would be considered on any combination of single and multiple lanes or winding/curving roads. However, proposed locations were reported to be single carriageways with one lane in each direction. The need to minimise the likelihood that vehicles might attempt to evade detection by driving in verges, the oncoming lane or straddling lanes was also noted.

5.1.7.2 Technological characteristics

A number of preferences were also reported regarding technological characteristics of point-to-point speed enforcement systems. This included the use of digital cameras and triggered infrared high-repetition flashes. Visible flash units are not being considered, given the risk of adversely affecting a driver's vision (e.g., blinding) or attention. While pole-mounted cameras on the side of the road are proposed, to reduce the costs associated with gantries or large cantilevered structures, it was stated that such an approach would be revised if strong evidence regarding low capture rates or vulnerability of the equipment to vandalism was identified.

It was noted that while the use of both forward and rear facing cameras would ideally be preferred, it was reported that adoption of such an approach was unlikely to be cost-effective, given traffic volumes and crash rates in the state. As a result, rearward facing cameras as a minimum were preferred. It was acknowledged that while such an approach would allow for the detection of motorcyclists, who are significantly overrepresented in serious casualty crashes in the state, difficulties would be experienced regarding the detection of some heavy vehicles. For instance, there may be difficulty in identifying the driver when a trailer and the corresponding number plates are owned by a company; or in identifying obscured plates (e.g., overhanging load, in a position not captured by the camera, dirty plates).

Based on evidence from other systems, a preference was expressed to locate the ANPR and plate-matching software at the roadside, with data and images for offending vehicles only sent to a central server. While the location and process in which data collected from the system is stored was yet to be determined, it was suggested that it would likely involve temporary and archival storage with appropriate security. It was reported that fibre optic cabling would not be available in the locations proposed for the initial rollout of point-to-point systems in the state and thus wireless communication networks would be required, with 3G a likely candidate given anticipated data volumes.

Indicative predictions regarding the type of data to be sent through to the back-office and for inclusion on the data block included an image of the offending vehicle; location, camera and frame; date and time; lane and direction; and offence type. With respect to the images, it was suggested that they would be required to be of sufficient quality to prove the offence in a court of law; able to locate the offending vehicle in relation to the road/markings; able to allow clear reading of the number plates in a variety of weather and lighting conditions; and of a file size large enough to give high resolution, but not so large that it diminishes the efficiency of the ANPR software or causes bandwidth issues for data transmission.

A number of proposals for security protocols were also reported. These included protecting the data through sufficient encryption to ensure integrity of evidence chain, access control rules and access logs. The precise processes for infringement adjudication, quality control, currency of certificates checks, authorisations to issue infringements and similar back-office activities were yet to be determined, however it was proposed that such activities would be undertaken by Tasmania Police, with human checks conducted before any infringements are issued.

5.1.7.3 Operational characteristics

The proposed model for the introduction of point-to-point speed enforcement systems in Tasmania is for the Department of Infrastructure, Energy and Resources to procure, own and operate the system/s, with appropriate contracted support for aspects of installation, maintenance, testing and certification. It is expected that the precise extent of private sector roles would be decided during the procurement stage. Encrypted files relating to detected speed infringement would then be directed to Tasmania Police, who would be responsible for the adjudication and processing of infringements.

The stakeholders reported that current certificates verifying that the system components have been maintained and tested would be needed before infringements could be issued, however the type and frequency of testing was yet to be determined. The technology used to synchronise the time clocks used in the system is also yet to be determined, however the importance of ensuring a reliable and accurate approach was reported as being critical, given that any error could compromise the entire system and rapidly erode community support. The methods used to verify and certify the surveyed distance between camera sites was also yet to be determined. Stakeholders suggested that the approach adopted would likely be based on evidence and experiences with methods employed in other jurisdictions.

Stakeholders reported that the proposed scope for the initial rollout of point-to-point systems is limited to average speed enforcement, with an additional capacity to enforce 100 km/h speed limits for heavy vehicles in 110 km/h zones. It was noted that any additional functionality, such as linking data collected by the system to licence/registration or criminal databases was not in scope, and would need to be expressly approved by Government.

5.1.7.4 Legislative characteristics

The initial approval and certification procedures involved with implementing point-to-point systems in Tasmania are yet to be determined. The stakeholders reported that based on advice from other jurisdictions, a number of legislative issues were being assessed. These include:

- Prescribed speed measuring device
- Definition of data relating to the calculation of speed
- Certification of devices and process of production of printed images of detected infringements
- Prescribed point-to-point process leading to issue of an infringement notice
- Average speed as evidence of actual speed (including the formula used to calculate average speed)
- Evidence of surveyed road distance and certification.

Given that the initial proposed roll-out does not involve instantaneous speed measurements or contiguous enforcement corridors, the need for a multiple infringement policy has not been addressed. The precise enforcement tolerance associated with point-to-point systems has not yet been determined but, similar to other automated speed enforcement approaches in Tasmania, would not be communicated to the public. It was reported that signs would be advisory and thus would not require legislative support. While the design and configuration of signage has yet to be determined, proposals would likely involve prominent signage, specifically pertaining to the measurement of average speeds (to maximise compliance), prior to the enforcement corridor and repeater signs at a minimum interval of 2.5 to 3 kilometre within the enforcement corridor.

Finally, it was noted that privacy issues and public acceptability may change over time in the state and thus, to mitigate any future privacy concerns, if the project is approved by Government, an external agency is proposed to conduct a Privacy Impact Assessment, from which a Privacy Management Plan will be developed.

While a range of exemptions are given for law enforcement purposes, and these exemptions may extend to information collected from a point-to-point system, it was acknowledged that there are risks in adopting this approach. Due to the quantity of personal information handled by point-to-point systems and the variety of additional purposes for which that information could potentially be used, it was recommended that the Government and community have clear and agreed guidance on:

- The purpose of the system and the purpose/s for which personal information collected by the system may be used
- Who can access the information
- Data storage, retrieval, archiving and destruction protocols
- Data security, access control, access logs
- Audit requirements for system security and privacy management.

The stakeholders reported that any project approved by Government will be required to undertake an external, independent Privacy Impact Assessment (PIA) that will identify potential privacy impacts and recommend options for managing, minimizing and/or eradicating these impacts. The PIA would then provide the basis for a Privacy Management Plan.

5.1.7.5 Broader issues

Broader speed management issues: Stakeholders argued that point-to-point speed cameras should be regarded as a complementary initiative to supplement traditional speed enforcement methods. That is, they suggested that an optimal speed management program will also include fixed and mobile speed cameras and general on-road enforcement and attempt to balance specific and general deterrence. The proposed initial roll-out would represent only a small proportion of the overall speed management strategy in the state, however expansion would be considered if successful road safety outcomes and cost-effectiveness is achieved.

A number of advantages and disadvantages associated with point-to-point speed camera systems were noted. Reported advantages include reduced distance and time halos experienced with fixed and mobile speed cameras; anticipated high levels of speed limit compliance, reductions in vehicle speeds (excessive speeds in particular) and subsequent reductions in traffic crashes; public and stakeholder perception of overtly operated point-to-point systems representing a ‘fairer’ approach to speed enforcement compared to instantaneous speed or covert cameras (although the requirement of these methods in the speed management strategy to achieve general deterrence was noted); the ability to create a network of enforcement zones along priority routes where serious crashes are a problem; and, that the approach frees up police resources for other locations. Reported disadvantages include the fact that the technology is relatively complex to implement; that rigorous certification and testing requirements are required; and that initial system changes are required for back-end processing.

Public education: Stakeholders reported that a public and stakeholder communications strategy was currently under development.

Evaluation: Stakeholders reported that any trial or implementation of a point-to-point speed enforcement system would be accompanied by plans to conduct an appropriate evaluation. It was reported that baseline and post-implementation evaluations for outcome indicators (e.g., quantity and type of crashes) and intermediate indicators (e.g., impacts on speeds) would be conducted and that project implementation would also be evaluated.

5.1.8 Northern Territory

5.1.8.1 Extent of use of point-to-point speed enforcement

While stakeholders in the Northern Territory stated that they were aware of point-to-point speed camera technology, they reported no immediate plans to introduce the approach. It was reported that any future implementation would likely focus on border to border tracking of vehicles, given the geographical characteristics of the state and the considerable distances between population centres. The capability to monitor vehicles over considerable distances was highlighted, given the fact that many routes have few or no exits. It was noted that sites would need to be protected physically and the equipment secured from damage or interference.

5.1.8.2 Technological characteristics

Given that no planned implementations of point-to-point speed enforcement systems were proposed at the time the stakeholder consultations were conducted, it was not possible for the involved representatives to comment on technological characteristics of the technology. No technological preferences were reported.

5.1.8.3 Operational characteristics

The stakeholders suggested that a long-term preference for point-to-point operation and management in the Northern Territory would be to outsource the system/s to a private company. This was noted as the proposed approach for other speed/red-light enforcement activities in the jurisdiction.

It was reported that maintenance schedules would be determined by manufacturer specifications to ensure compliance and reliable data capture for enforcement purposes. This would be done in a similar fashion to processes already in place for breath analysis, radar and laser equipment servicing and calibration.

It was reported that current tolerances would also be applied to any implemented point-to-point system. In the Northern Territory such tolerances are not publicised to avoid the creation of de facto speed limits.

The stakeholders reported that given that all relevant databases are government owned and operated, linkage to such databases from information collected from point-to-point systems would be expected and desirable.

5.1.8.4 Legislative characteristics

The stakeholders outlined that approval and funding would be required from Government prior to the implementation of point-to-point enforcement systems. It was also expressed that systems installed would be required to align with systems implemented in other Australian jurisdictions. It was noted that the approval and certification of the equipment would occur via government gazettal of the devices. In respect to legislative changes, it was reported that amendments to the Northern Territory Traffic Act and Regulations would be required, a process that would take up to 12 months from submission of the request to the appropriate governmental departments.

It was reported that signage policies and practices would likely be determined based on an analysis of the policies and practices enacted by other jurisdictions with point-to-point systems and the requirement to comply with any standards.

The stakeholders acknowledged that privacy issues typically occur when images of motorists are captured in a public place. It was noted that because the databases are government owned and freedom of information (FOI) issues had already been addressed in the state, insurmountable privacy considerations were not anticipated. In addition, it was noted that plans to outsource the operation and management of the systems would create additional requirements, including security clearance of employees and signed agreements to protect the data. The stakeholders reported that such processes were already occurring in the jurisdiction in relation to the management of fixed site red light/speed cameras.

5.1.8.5 Broader issues

Broader speed management issues: Current enforcement methods to manage vehicle speeds in the Northern Territory include police patrols using mobile radar and hand-held laser, and fixed and mobile speed cameras. It was noted that any new and innovative approach to speed enforcement, such as point-to-point, would provide an enhanced capacity to reduce road trauma through limiting excess speeds. In addition, the benefits associated with monitoring and managing driver fatigue among the heavy transport industry was also highlighted. It was argued that the application of point-to-point enforcement systems should not be constrained by state borders. Perceived disadvantages of the approach included the delay between commission of the offence and the administration of an infringement, the inability to stop the offence as it occurs and the resources expended when the driver is not readily identified in the first instance.

5.1.9 New Zealand

5.1.9.1 Extent of use of point-to-point speed enforcement

In New Zealand, a single trial of point-to-point speed cameras is being conducted in Auckland at a roadworks site. The site involves the Newmarket viaduct running north-to-south, raised 10-15 metres off the ground. Due to concerns associated with the structural integrity of the viaduct to withstand earthquakes and the inability for the current six-lanes (three lanes in each direction) to accommodate increasing traffic volumes into the city, the viaduct is being upgraded. The four stage process involves: (1) the creation of a new four-lane southbound section to the east of the existing viaduct; (2) demolition of the existing northbound section; (3) creation of a new three-lane northbound section; and (4) demolition of the existing southbound section. The construction of the new viaduct is conducted using the 'Big Blue' gantry crane (see Figure 5.1). The trial is expected to continue for the length of the construction project, which is expected to be completed in early 2012.

Source: Auckland Motorways Website (http://www.aucklandmotorways.co.nz).

Figure 5.1: Image of the roadworks site – Newmarket Viaduct, and the 'Big Blue' gantry crane being used to construct the new sections.

While the trial implementation of the technology will not involve an enforcement component, it was proposed that warning letters would be sent to motorists detected as travelling in excess of the prescribed speed limit through the roadworks section. Initial plans involved a series of two letters to be sent to motorists exceeding the speed limit. The first letter was intended to be sent from the perspective of a road worker, with a message to the effect of: 'I am working nearby to where you are driving and you are risking my life'. A second letter, sent to motorists detected exceeding the speed limit twice, was intended to present a message to the effect of: 'The next time you are detected speeding at this location your information will be forwarded onto the Police'. However, the Automobile Association (AA) did not want such letters to be used, so this process is currently on hold.

The stakeholders reported a somewhat unique site selection process, whereby a speeding problem was identified at a roadwork site and the requirement for an innovative approach to speed enforcement was highlighted. Specifically, speed data provided evidence that 30 000 vehicles were exceeding the speed limit per day, with 10 000 exceeding the speed limit by more than 10 km/h and 1 000 by more than 20 km/h.

The stakeholders argued that there is the potential for a speeding motorist to cause a heavy vehicle to crash into the gantry crane. It was noted that while such an event was of low probability, the consequences and costs associated with such a crash would be substantial. The trial site will initially involve a one kilometre stretch of the northbound 3-lane section of the viaduct, employing existing gantries to mount the equipment. However, during the course of the trial the monitored section will increase to 1.5 kilometres due to the relocation of one of the gantries. The speed limit along the entire monitored stretch is 70 km/h, representing a reduced speed limit due to the roadworks. It was explained that the absence of a system on the southbound lanes was due to resource constraints. The location details of the trial point-to-point system are outlined in Table 5.11.

Table 5.11: Location of trial point-to-point speed enforcement system in New Zealand.

Location	Length of enforced section	Speed limit	Status of system
Newmarket Viaduct, Auckland	1.5 km	70 km/h	Trial

5.1.9.2 Technological characteristics

The trial system will involve a single entry and exit point, with a total of six cameras mounted to existing overhead gantries. Specifically, each point will include two monochrome plate cameras, each monitoring 1.5 lanes, and a single colour scene camera. Forward facing cameras will be employed due to the specific problem associated with spray from the rear tyres of vehicles during wet road conditions. The cameras will be triggered through continual video streaming. On-site processors will communicate with the back-office and send data and images of infringing vehicles only. During the first month of the trial a total of 20 hours per week of human checks will be conducted to verify the accuracy of the system. During this time no warning letters will be sent to offending motorists. Future decisions of the degree of human verification in back-office proceedings will be based on evidence from this process.

The technological characteristics of the New Zealand trial point-to-point speed enforcement system are provided in Table 5.12.

Table 5.12: Technological overview of the trial point-to-point speed enforcement system in New Zealand.

System Component	Specific Characteristics
Cameras & Illumination	
Number of cameras	6 (3 at each of the entry and exit points) – 2 plate cameras monitor 1.5 lanes each while 1 scene camera monitors all lanes
Number of camera sites	N/A
Camera resolution	High definition cameras – precise resolution unknown
Digital or analogue	Digital
Monochrome or colour	Plate cameras = monochrome; scene cameras = colour
Camera activation	Continual video streaming
Forward or rearward facing	Forward facing
Camera per lane or multiple lanes	Plate cameras monitor 1.5 lanes each while scene camera monitors all lanes
Illumination approach	Infrared
Infrastructure	
Camera mounting approach	Overhead mounting to gantries
Purpose built or existing	Existing infrastructure
Camera housing approach	N/A
Power source	N/A
System Software & Processors	
Software characteristics	PIPS provided
Matching approach	N/A
Location of processor	At the site of the camera/flash unit – can store up to 60 000 vehicle events locally
System hardware	N/A
Clock synchronisation	GPS = primary reference; SNTP = secondary reference
Size and type of image data file	N/A
Data storage approach	N/A
Additional data captured by system	None
Communications Network & Back Office	
Communication network approach	Wireless 3G
Data sent to back office	On-site processors communicate with back-office. If infringement is detected the back-office requests data and image – data is encrypted prior to transmission
Degree of back-office automation	For the first 4 weeks of the trial, 20hrs/week of human checks will be conducted and no warning letters sent. Future decisions of human involvement in back-office proceedings made based on evidence of that process

5.1.9.3 Operational characteristics

The system will be operated by the Auckland Motorway Alliance (AMA), a maintenance alliance made up of the New Zealand Transport Authority (NZTA), two contractors and three consultants. In addition, both the regional and national police organisations sign off on the project and communications plans, as well as the legal counsel within NZTA and national communications, and the Minister for Transport will be informed of the project.

While the specific maintenance schedules had not yet been determined, it was reported that they would likely be conducted at least every six months, with realignment a probable factor to consider due to the construction occurring on the road. The stakeholders reported that GPS would be used to synchronise the time clocks involved in the system as a primary-time reference, with simple network time protocol (SNTP) as a secondary reference. Since there are no plans for enforcement at this site, it was reported that the measurement of distance between camera points would be somewhat less rigorous than if enforcement were to be undertaken. It was reported that measurement be conducted during the implementation process, when the road is closed to traffic, and will involve walking the road section with a hand held measuring wheel.

There are currently no plans to link information collected from the system to other databases (e.g., unregistered vehicles, unlicensed motorists, outstanding warrants); however there would be scope to revisit this aspect of functionality in the future. A detection threshold will be incorporated into the system, with the specific level to be determined during the initial four week period of the trial. Specifically, during this initial period, no detection threshold will be enacted such that the system will detect all vehicles over the posted 70 km/h limit. Depending on the proportion of vehicles exceeding the speed limit by various degrees, decisions will then be made regarding an appropriate detection threshold taking into account resource issues.

5.1.9.4 Legislative characteristics

Given that the implementation of the point-to-point speed cameras represents a technological feasibility trial with no formal evaluation component, there will be no need to address any type approval or certification procedures prior to implementation. However, it was noted that an extensive process would be involved if the device was to become functional in an enforcement capacity.

It was reported that signage for the point-to-point system would not be involved in the first month of the trial. Following that period, signs will be erected immediately prior to the monitored section, reading ‘Average Speed Camera’ and including a pictogram of a camera. The installation of these signs will be accompanied by a publicity campaign highlighting the trial.

5.1.9.5 Broader issues

Broader speed management issues: Current speed enforcement approaches adopted in New Zealand include overtly operated fixed cameras and both overt and covert mobile speed cameras, as well as general police patrols. While definitive plans are yet to be determined regarding the full-scale implementation of point-to-point systems for speed enforcement purposes beyond the proposed trial, a number of stakeholders have expressed interest in a desire to use the technology in the future. The use of point-to-point systems is perceived to be a particularly useful approach for crash prone sections of road, with the high levels of compliance cited as a primary advantage, as well as the subsequent anticipated reductions in traffic crashes. In addition, it was argued that improved traffic flows associated with reduced speed variations may allow for increased speed limits, noted as a common criticism of high speed roads by motorists. Perceived disadvantages include the potential for privacy complaints and the increased costs associated with the technology. However, it was acknowledged that the latter could be mitigated through reductions in social costs associated with offending and crashes.

Public education: Stakeholders commented that all aspects of public education and awareness campaigns will not focus particularly on the introduction of the point-to-point system. Rather, information conveyed to the public would focus on the reinforcement of more general road safety and safe speed messages.

Evaluation: An evaluation of the trial is expected, and will focus on effects on speeding behaviour, rather than a formal technological evaluation.

5.2 Additional findings from the working group conducted with stakeholders from Australia and New Zealand

5.2.1 Enforcing average speeds across non-discrete speed zones

An issue that received considerable discussion during the working group was that of the practical and legislative issues associated with enforcing average speeds across non-discrete speed limit zones (e.g., across a section of road where the speed limit changes, say from 100 km/h to 80 km/h, during the enforcement corridor). Two particular issues dominated discussions: (i) the calculation of average speed between two points on a stretch of road that has multiple speed limits within a single enforcement corridor (practical issue); and, (ii) whether a separate 'average speed offence' needs to be created (legislative issue). Indeed, a number of stakeholders from various jurisdictions considered it to be problematic to implement point-to-point speed enforcement systems across non-discrete speed zones, even if they perceived it technically feasible to do so.

Currently, the only Australasian jurisdiction that enforces average speed across non-discrete speed zones is New South Wales. While a new offence category was not created, the legislation that dictates the formula used to calculate average speed is such that an offence is committed if the average speed is above the average speed limit. Specifically, if a motorist argues they were driving slower than the speed limit in one zone covered by the system, then they are subsequently providing evidence that they were exceeding the speed limit by a greater amount in the second zone covered by the system.

In addition, it was noted that enforcing average speeds across road sections with non-discrete speed limits increases the importance even further of implementing a stringent management approach to identifying incidents that occur within the enforced section which may affect the shortest practicable distance. For that reason, New South Wales stakeholders reported a focus on the development of sound working relationships between the Compliance and Enforcement Branch and organisations whose actions have the potential to impact the road alignment (e.g., road works), and in turn affect the shortest practicable distance on the enforced section.

5.2.2 Enforcement tolerances

Overall, working group members agreed that each jurisdiction should be responsible for managing enforcement tolerances according to their own jurisdictional needs, with different jurisdictions influenced by varying factors. Some stakeholders reported a desire to adopt lower tolerances for point-to-point enforcement than for other forms of automated speed enforcement, as well as adopting lower tolerance levels for longer enforcement zones. However, Victorian stakeholders noted a reluctance to adopt this type of approach because of the likelihood that it may lead to lower levels of community acceptance. The general preference among the majority of stakeholders was to adopt an enforcement tolerance in association with point-to-point systems that was consistent with tolerances employed for other automated speed enforcement approaches in the jurisdiction.

5.2.3 Legislative and evidentiary considerations

A number of stakeholders noted that there is considerable between-jurisdictional variance in the specific characteristics of requirements for certification and testing. It was argued that such variation increases the difficulty associated with establishing appropriate testing and certification benchmarks to support prosecutions.

5.2.4 Mobile point-to-point speed enforcement

There was also considerable discussion relating to the use of mobile point-to-point enforcement systems. It was noted that current examples of mobile systems (implemented overseas) have largely been restricted to use in road works zones and have typically involved trailer-mounted technology or temporary infrastructure. However, stakeholders were particularly interested in the utility of the technology for use in current mobile speed camera vans.

A number of advantages were noted with regard to mobile point-to-point speed cameras. Firstly, it was suggested that such an approach may reduce negative public attitudes toward current mobile speed enforcement efforts, given that the measurement of instantaneous speeds only is often perceived to be 'unfair'. In addition, the approach was argued to increase the deterrent effect associated with mobile speed camera operations, such that motorists would be unsure when passing a mobile speed camera van if they were passing a camera that measures instantaneous speeds only or average speeds between two points, and thus might be encouraged to drive at the posted speed limit for a longer duration.

A number of jurisdictions reported current or impending plans to trial the approach. South Australian stakeholders also expressed a desire to use two existing mobile speed camera sites and vans for mobile point-to-point operations, with data manually transferred to the back office for processing. Finally, Victorian stakeholders also reported that they are currently considering mobile point-to-point and investigating the legislative requirements for its introduction. All stakeholders acknowledged that certification of equipment and distance measurement would be critical.

Such discussions also created debate regarding the use of point-to-point speed enforcement systems on urban roads, specifically in relation to lower-speed sections of road. Both New South Wales and ACT stakeholders acknowledged the potential application of point-to-point speed cameras in urban environments. Of particular concern were the requirements of criteria in the selection of enforcement locations. While crash histories and speed profiles were acknowledged as typical criterion used, it was noted that enforcement operations are inevitably determined according to local and political conditions in each jurisdiction.

5.2.5 Shortest practicable distance

An accurate calculation of average vehicle speed across the section enforced by a point-to-point system requires a precise measurement of the shortest practical distance between points in the system. The previous sections have highlighted that all jurisdictions have stringent surveying and certification procedures in place to ensure accurate and traceable measurement of this distance. However, stakeholders agreed that re-certification and the management of factors affecting shortest practical distance (e.g., changes to signage or the road alignment) are also critical issues to be considered, given that changes to the road alignment or location of particular road signs can compromise the integrity of the speed measurement process. It was agreed that mandatory schedules should be developed to ensure recertification is conducted regularly, and that regular signage and length inspection and management arrangements also be developed.

5.2.6 Environmental/noise reduction benefits

As stated previously, environmental benefits have been reported in association with the implementation of point-to-point enforcement systems, through reduced vehicle emissions and noise (see Section 3.4). However, the extent of this literature has been exclusively limited to studies conducted internationally. Considerable concerns were expressed regarding the feasibility of using environmental benefits associated with point-to-point speed enforcement as a ‘selling point’ in Australia. Specifically, it was argued that the introduction of the approach in Australia is typically not based on the goal of reducing vehicle emissions and noise.

Concerns were also expressed regarding the ability to evaluate such objectives. Indeed, none of the representatives from involved organisations reported sampling air quality prior to implementation. Stakeholders from New South Wales acknowledged that congestion, and the associated problems of vehicle noise and emissions, will be a potentially important factor to consider in the future. They reported that ‘noise cameras’ are currently being trialled in Sydney, but there is currently no legislation to enforce such. However, working group discussions also highlighted that evaluations of environmental benefits should not focus exclusively on the measurement of localised changes in air quality, given that dispersion of emissions, particularly in rural areas, are likely to reduce the ability to identify significant changes in air quality. Nonetheless, some environmental benefits associated with reductions in vehicle speeds were perceived to be likely.

5.2.7 Clock synchronisation

The synchronisation of clocks used in point-to-point enforcement systems was also an issue that was perceived as fundamental by the majority of stakeholders participating in the working group. It was agreed that ensuring all systems are synchronised to an identical time, and that the measurement of time was ‘traceable’, were the primary concerns. Whether the systems were linked to the ‘actual time’ was perceived to be a secondary matter.

A number of stakeholders from various jurisdictions expressed a desire for the identification of best practice principles specific to the issue of clock synchronisation, reflecting the importance of this component to the overall accuracy of the systems. However, working group representatives noted that, at the time, no clear recommendations had been offered on this matter. As a result, jurisdictions reported having made their own decisions regarding clock synchronisation. The majority of stakeholders suggested that the current report would benefit from making a recommendation specific to this issue to be used as a national standard. Importantly however, concerns were expressed regarding the implications that a national standard may have for the current practices already in place in individual jurisdictions. Therefore, there was consensus within the working group that although beneficial, a national recommendation about specific clock synchronisation procedures would not necessarily prove helpful from policy or operational perspectives.

5.2.8 Other technological aspects

A number of technological aspects were also discussed further during the working group. These included the specific approach to infrastructure and power source that is chosen.

It was noted that the infrastructure chosen for point-to-point speed enforcement systems must consider the width of road and number of lanes. It was noted that if pole mounted approaches are to be employed, that there may be a requirement to fit poles on either side of the road to ensure capture rates are maintained. Indeed, one stakeholder noted that preliminary tests had shown that up to 7% of infringing vehicles escape detection when a pole-mounted system is only installed on one side of the road. It was also noted that infrastructure that is closer to the ground is at a greater risk of vandalism.

The cost of power to the location of the camera, flash and other equipment was highlighted as an important issue, given that this is an expensive component of installation. A number of stakeholders from various jurisdictions noted that the costs associated with accessing power sometimes created situations whereby installing the cameras at the ideal location may be prohibitive, and that this was particularly problematic in rural areas. Moreover, access to power was also reported to enhance the difficultly associated with estimating how much a new point-to-point installation would cost. The majority of stakeholders agreed that the use of solar power is an unreliable approach. Stakeholders from New South Wales and Western Australia reported that solar panels have previously been stolen and vandalised when used in other roadside applications. It was noted, however, that the use of solar power options are becoming more viable as flash technology has lower power requirements.

5.2.9 Automation of the back office operations

Working group discussions revealed that all involved organisations perceived point-to-point systems as having greater integrity when human intervention is involved in the processing of infringements. Indeed, the majority of jurisdictions highlighted a preference for human verification of all infringements. It was noted that full automation of point-to-point systems is least viable where the numberplate management regime is not consistent, such as in Australia, where the manufacturing and design of number plates do not have consistent standards and manufacturing is conducted at the state level.

5.2.10 Between-jurisdiction sharing of information

A number of stakeholders highlighted the fact that different jurisdictions collect and store varying levels of information and that these discrepancies represent a fundamental barrier to interstate enforcement efforts. Furthermore, Victorian stakeholders reported experiences that, due to the outsourcing of particular aspects of speed enforcement in the state, some other jurisdictions have been unwilling to provide information to assist in apprehending interstate vehicles detected committing offences in Victoria. They suggested that some states would prefer the sharing of information to occur through police services only.

5.2.11 Number plate manufacturing and readability

The impact of the commercialisation of number plates for camera-based enforcement programs also received considerable discussion in the working group. A number of particular concerns were expressed including the large degree of variation in number plates (both nationally and within a single jurisdiction) and the duplication of alpha-numerical sequences. South Australian stakeholders noted that duplication of alpha-numerical sequences had occurred within the state. Victorian stakeholders noted that over 300 variants of number plates exist in their jurisdiction and advised that they have developed an agreement that sees each proposed new number plate tested by IMES prior to the implementation of the new plate design to ensure it can be detected by enforcement cameras. New South Wales stakeholders noted that they are in the process of developing a number plate testing facility to test all new number plate formats in a controlled and consistent way. Overall, it was agreed that number plates should avoid using glossy numerals and letters or a glossy background, and that the reflectivity of the numbers and letters on the background should be assessed prior to the release of the plate. In addition, there were arguments that the same sequence of numbers and letters should not be issued on more than one number plate within the same jurisdiction, irrespective of the design of the plate. It was further suggested that this restriction should ideally occur at a national level also.

5.2.12 Evaluating point-to-point speed enforcement systems

Working group discussions highlighted that all organisation representatives perceived evaluating the effectiveness of point-to-point speed enforcement implementation as a critical task. Moreover, the majority expressed a need for guidance in the development of a scientifically sound and rigorous evaluation design. It was suggested that jurisdictions must give considerable forethought to the development and planning of evaluations to ensure accurate and valid data collection. It was noted that it is important to factor in the costs associated with conducting evaluations into project development costs.

Discussions suggested that a number of issues must be considered when planning evaluations, including:

- Ensuring collection of baseline (pre-implementation) data
- Ensuring data is collected for appropriate time periods to allow for changes in outcomes to be examined though significance testing
- If feasible, selecting both treatment and control sites (matched for appropriate comparison), and selecting these sites prior to the implementation of the technology
- Collecting data relevant to key outcome variables (e.g., speed data profiles, crash data)
- Collecting data related to public perceptions of the enforcement approach and technology both pre- and post-implementation.

Also of interest was an investigation of the halo effects associated with point-to-point systems. The stakeholders acknowledged evidence from evaluations of fixed and mobile speed cameras (measuring instantaneous speeds) that suggests the impact of the enforcement on behaviour dissipates less than a kilometre after passing the camera location. There was debate regarding whether covering a larger proportion of the road network, through the implementation of point-to-point systems, would translate to better compliance across the entire network, even where point-to-point speed enforcement was not implemented. While the majority of stakeholders acknowledged that point-to-point speed camera systems had the potential to influence behaviour for a longer duration, given that they enforced longer sections of road, Victorian stakeholders reported a halo effect of approximately 200-250 metres beyond the enforcement corridor associated with point-to-point in the state.

Finally, it was argued that evaluations should not focus solely on reducing the frequency of crashes, and must also investigate crash severity. Specifically, it was suggested road safety benefits can be achieved when the severity of traffic crashes are significantly reduced, even if the frequency of crashes is not significantly reduced.

5.2.13 Consultations with Australian Motoring Groups and Additional Organisations

A number of additional organisations were contacted during the stakeholder consultation phase. These included motoring organisations from each of the jurisdictions (with the exception of the Northern Territory), as well as specific motorist groups (e.g., motorcyclists, trucking industry) and other organisations related to measurement and privacy. The list below highlights those organisations that were consulted:

- Royal Automobile Club of Queensland (RACQ) – Queensland
- Royal Automobile Club of Victoria (RACV) – Victoria

- Royal Automobile Club of Tasmania (RACT) – Tasmania
- National Roads and Motorists Association (NRMA) – New South Wales & the ACT
- Royal Automobile Association (RAA) – South Australia
- Royal Automobile Club of Western Australia (RAC) – Western Australia
- Motorcycle Council of New South Wales (MCC) – New South Wales
- Australian Trucking Association (ATA) – National
- National Measurement Institute (NMI) – National
- The Office of the Australian Information Commissioner (OAIC) – National
- Professor Max Cameron.

These organisations provided background information and information regarding the level of support for the use of point-to-point speed enforcement in each jurisdiction. This information was deemed to be outside the scope of the consultation phase of the research, which was focussed on identifying best practice principles. Thus, only the consultations conducted with the NMI, OAIC and Professor Max Cameron are reported here. A summary of the responses from these stakeholders is provided in Appendix C.

5.2.13.1 National Measurement Institute (NMI)

The NMI explained their role as being responsible for 'technical infrastructure'; they set national standards of measurement so that all states work from identical measurement, thereby giving strength to legislation involving measurements (e.g., shortest practicable distance) by providing traceability to a common measurement. The Commonwealth does not mandate adherence to these measurements, however if a jurisdiction attempts to regulate their own measurements, the Commonwealth measurements have precedent in any dispute arising. Thus, all states adhere to these standards in association with enforcement of speeds. Traceability allows for measurements to be evidential when pursuing infringements, to the highest standard of law in the country.

The NMI is not a regulator and is not responsible for assessing the accuracy of the measurements used by organisations. Instead, the NMI provides the base measurement which organisations then use as the basis for their own measurements. Thus, surveyors who assess shortest practicable distance must employ tools that have been certified as measuring the various metrics in question with traceability back to the national standards set by the Commonwealth. It was noted that certification is a general term which has few legal ramifications. It was reported that what is important is that a device has a certificate of patent approval (e.g., type approval for the device); a certificate that it is traceable to the Commonwealth standards of measurement (e.g., shortest practicable distance); and, is capable of keeping to a particular calibration and was appropriately calibrated at the time of the regulatory measurement (e.g., at the time of the infringement being detected). These certificates can then be used in legal proceedings as evidence of the veracity of the measurements used for the regulatory purpose.

5.2.13.2 The Office of the Australian Information Commissioner (OAIC)

The OAIC is an independent statutory agency headed by the Australian Information Commissioner and has three broad functions (Privacy, Freedom of information, and Information Commissioner) under the Privacy Act 1988 (Cth) (Privacy Act). The Act protects the personal (identifiable) information of individuals handled by Australian Government agencies and personal information held by all large private sector organisations, private health service providers and some small businesses. The potential privacy issues associated with point-to-point speed enforcement systems include:

(i) Inconsistent privacy protection across jurisdictions

The level of privacy protection may vary depending upon the relevant jurisdiction in which the point-to-point speed enforcement system is located. To address potential gaps in privacy protection, the OAIC suggests that each State and Territory should introduce a uniform legislative framework that includes privacy protections and complaint handling mechanisms for point-to-point speed enforcement systems. This may involve one State implementing model legislation setting out the applicable legislative framework and all other States and Territories passing legislation applying or mirroring this framework. A similar approach has been adopted within the context of other national regulatory schemes. The OAIC believes that a best practice guide for the implementation of point-to-point speed enforcement systems would play an important role in any national legislative framework for point-to-point speed enforcement systems. Regardless of whether speed camera images and other information collected would fall within the Privacy Act's definition of 'personal information', it is preferable for there to be appropriate privacy practices in place across all jurisdictions.

(ii) Notice and collection

Generally, under the Privacy Act, individuals are afforded protections to assist in controlling the dissemination of information about them. Legislative frameworks should include a provision that imposes an obligation on State road transport or law enforcement authorities to make individuals aware of how their personal information may be collected, used and disclosed. In addition, any system should be predicated around collecting only the minimum amount of personal information necessary and have legislative measures in place to ensure all information is kept accurate, complete and up to date.

(iii) Use and Disclosure

Legislative frameworks should contain strict provisions around the use and disclosure of personal information collected. Any use or disclosure should only occur if it is related to the specific purpose for which the information has been collected or is otherwise stipulated under the Privacy Act. This approach minimises any unauthorised access to an individual's personal information.

(iv) Security

Legislative frameworks should set out minimum security measures that should be adopted to protect personal information. These measures should canvass all aspects of physical, computer and communications security including user permissions, authentication of access, data encryption, auditing and monitoring requirements.

(v) Access, correction and complaint handling processes

Legislative frameworks should give individuals the opportunity to access and correct (if necessary) information pertaining to them and complain if they are concerned about the way in which their personal information is handled. Instituting such mechanisms facilitates community confidence in the enforcement initiative. A consistent and uniform complaint handling process should be established as part of any uniform legislative framework and is particularly important in circumstances where information collected from point-to-point systems may be shared between various road transport and law enforcement entities.

(vi) Data aggregation and linkage

There is the possibility that the use of point-to-point speed enforcement systems will lead to the aggregation and/or linking of data about an individual (e.g., licence plate numbers linked to an individual's name and address). Data aggregation may enable new uses of personal information beyond the expectations of the individual and without their knowledge or consent. Legislative frameworks should ensure any data aggregation or linkage occurs only in limited circumstances and within strict guidelines.

(vii) Data destruction

Legislative frameworks should contain a provision which provides for the destruction of data that is no longer required. Implementing retention and disposal policies for information collected will improve the quality of data holdings and ensure any law enforcement decisions resulting from data are made on the highest quality information available.

Collecting information about drivers who are yet to have committed an offence and using data collected by the system for purposes other than speed enforcement.

The OAIC is of the view that the purposes for which any personal information is collected under a point-to-point speed enforcement system and any uses or disclosures of that information should be clearly articulated in legislation. This will assist in preventing the unnecessary collection of personal information and any unauthorised uses or disclosures. It can also ensure personal information handling under a point-to-point speed enforcement system is subject to appropriate oversight and accountability mechanisms. This can be achieved by way of a privacy impact assessment (PIA) and it enables individuals to be informed about how their personal information may be used or disclosed. Accordingly, using data collected by point-to-point speed enforcement systems for uses other than speed enforcement should only occur in circumstances where there is express legislative authority.

In some circumstances there may be an incremental expansion in the purpose for which a system is used, to the point that it is employed for purposes that were not initially agreed to or envisaged. This expansion in purposes is described as 'function creep' and is usually organic in nature and lacks overall direction, planning or oversight. Any proposed use of data for purposes other than speed enforcement should be the subject of a PIA to ensure the correct balance is achieved between individuals' right to privacy and the public interest. The '4A Framework' is a guide to balancing these competing priorities and is intended to assist government agencies in considering personal information handling issues in their legislative measures specifically relating to new law enforcement or national security powers. It is underpinned by the recognition that measures that diminish privacy should only be undertaken where these measures are: necessary and proportional to address an identified need, and subject to appropriate and ongoing accountability measures and review.

The OAIC suggests that the 4A framework may be a useful tool for ensuring any proposal to use data collected by point-to-point speed enforcement systems for uses other than speed enforcement only apply in circumstances where it is necessary and proportionate to facilitate information sharing between law enforcement agencies undertaking their legitimate functions. Four steps to mitigate any potential privacy issues relating to the use of point-to-point speed enforcement are noted here and described in greater detail in Appendix C: i) Clearly define the purpose of point-to-point speed enforcement systems; ii) Conduct a PIA; iii) Establish a uniform privacy framework; and iv) Minimise potential for function creep.

5.2.13.3 Professor Max Cameron – Speed Camera and Road Safety Expert

Professor Cameron was included in the stakeholder consultation process because of his international expertise and experience in evaluations of a wide variety of speed enforcement approaches, including point-to-point speed enforcement.

Overall, point-to-point speed enforcement was perceived to be one approach of many within an overall speed management strategy. A one-size-fits-all approach is unlikely to work and jurisdictions will differ in relation to the range and extent to which differing approaches are employed. Point-to-point speed enforcement may be particularly beneficial for use in states with a high proportion of rural/regional roads (e.g., Western Australia, Queensland). Specifically, many rural highways are conducive to high speeds, such that roads are typically straight and level and motorists can travel long distances without passing through towns. In addition, many roads are undivided, in relatively poor condition, with unsealed shoulders and there is an unusual mix of traffic (including high proportions of heavy vehicles). Thus, in the event of traffic crashes the consequences can be particularly severe. On such roads, instantaneous speed enforcement (e.g., fixed and mobile speed cameras) has a minimal zone of influence on behaviour. Alternatively, point-to-point speed enforcement can have more considerable and network-wide impacts on behaviour, particularly when there is limited opportunity or incentive to deviate from the enforced route.

One issue with the use of point-to-point speed enforcement in urban and residential settings is the likelihood that a substantial proportion of motorists will not pass through both the entry and exit points, given the increased opportunities for access and egress. Thus, motorists may speed within the enforced section and not be captured by the system. However, this was not seen as jeopardising the overall effectiveness of the system and was more likely to be questioned from a political or judicial perspective given that not all motorists would be monitored by the approach. Moreover, there is potential for short, mid-block applications of point-to-point technology on urban arterial roads, where there are few opportunities or incentives to deviate from the enforced route, to be perceived as a more appropriate speed management approach compared to the use of fixed or mobile speed cameras. In addition, it was noted that the use of point-to-point speed enforcement systems represents a more effective approach of speed enforcement compared to multiple installations of fixed speed cameras, particularly on urban freeways.

It was noted that there is scope for jurisdictions to focus public education efforts on the likely perceived fairness of the prosecution of average speed offences, given that many motorists justify instantaneous speed offences as a rare aberration of their behaviour (whether this is true or not). However, consideration must be given to ensure the promotion of the fairness of point-to-point speed enforcement is not conveyed at the expense of other approaches to speed enforcement, such that motorists do not perceive other methods to be less fair. It was recommended that the focus should be that speed is measured in a more thorough sense and thus offences detected in this manner are fair and largely inexcusable.

It was argued that claims that motorists will attempt to deliberately circumvent point-to-point speed enforcement systems by taking alternative routes or stopping within the enforcement corridor are largely unfounded. Instead, it was argued that the majority of motorists typically accept the approach and ultimately modify their behaviour, with the potential for subsequent attitude change and broader changes in social norms. This was seen as particularly true when point-to-point systems are implemented in locations with limited incentives and opportunities for access and egress, such that it becomes easier for motorists to comply than to attempt to avoid punishment.

There is a critical need for more scientifically rigorous evaluation of the road safety and other benefits associated with point-to-point speed enforcement. This is particularly relevant in Australia, given that many jurisdictions are driven by evidence that enforcement programs have clear road safety benefits. Evaluations should have adequate baseline and follow-up data collection periods (particularly in relation to crash evaluations) and assess a broad range of outcomes. Specifically, evaluations should not be restricted to assessing the impact of the approach on average vehicle speeds, but should also examine speed variation, 85th percentile speeds and the proportion of excessive speeders. In addition, the use of risk-weighted statistics and comparison routes also need to be considered to increase the rigor of evaluations and the diffusion of benefits (or impact on network-wide behaviour) should be investigated.

5.3 International stakeholder consultations

Point-to-point speed enforcement systems have been used extensively in a number of other countries. Indeed, at the time the project was conducted, systems were operational in the United Kingdom (England, Scotland and Northern Ireland), the Netherlands, Austria, Italy and Switzerland. In addition, the technology was being trialled in Belgium, a trial was pending in France and a previous trial had been undertaken in Finland. Finally, stakeholder consultations also suggested the trial or full implementation of systems in the Czech Republic, Norway and Spain, however these claims could not be verified through consultations with stakeholders from these countries. Due to several reasons outlined in Section 2.2, representatives from appropriate organisations could not be consulted in all countries.

The following sections present the findings from the international stakeholder consultations. Those countries from which stakeholders were consulted were: (1) England; (2) Scotland and Northern Ireland; (3) the Netherlands; (4) Austria; (5) Italy; (6) Switzerland; (7) Belgium; (8) Finland; and, (9) France.

5.2.14 England

The use of speed cameras in Great Britain began in 1992 and were initially purchased and operated by the police. Given that speed cameras represent a relatively expensive speed management countermeasure, very few cameras were operated during these first years. In order to assist the police and local authorities to maximise the benefits from speed cameras, a pilot was conducted in 2000 involving the organisation of partnerships between relevant stakeholders, such as the police, the local highways authorities (LHAs) within the force area, Her Majesty's Court Services (HCMS) and the Highways Agency (HA), who are responsible for the national trunk road network. These partnerships were able to offset the capital purchases and on-going operational costs associated with speed cameras against revenue generated through infringements, under rules set out by the government, namely the Department for Transport (DfT).

The trials proved successful and the offer to create these partnerships was extended to all GB police forces and by the final year of the programme's operation (2006-07) only two police force areas (North Yorkshire and Durham) remained outside the programme. In order to operate under the programme the partnerships had to abide by the Handbook of Rules and Guidance which includes site selection criteria for different types of enforcement site. Sites proposing to utilise point-to-point speed cameras had to meet the same criteria as fixed speed cameras. Under the programme, partnerships were required to provide evaluation data, including before and after installation numbers associated with crashes (fatal, serious and slight) and speed profiles (traffic volume, average speed, 85th percentile, proportion above the speed limit/excessively speeding).

After the end of the programme in March 2007, partnerships were no longer allowed to claim back costs from fine income and funding was replaced with a grant. Without this control partnerships were free to use their own site selection criteria.

NOTE: The information contained herein this Figure was provided by the DfT for the current project.

Figure 5.2: A brief history of speed cameras in Great Britain.

5.2.14.1 Extent of use of point-to-point speed enforcement

A brief history of speed camera operation and management is provided in Figure 5.2. The use of point-to-point speed enforcement on British roads has increased considerably since its initial inception in 1999 when it was trialled in Kent (Palmer, 1999). The first full implementation of the technology occurred in Nottinghamshire in July 2000 on two urban ring roads as part of the Nottingham Casualty Reduction Partnership. More recently, point-to-point systems have been installed at numerous other locations throughout the country. However, stakeholders still reported that levels of use had been limited by the costs associated with installation and the difficulties associated with identifying suitable enforcement areas under hypothecation guidelines.

Prior to the use of any enforcement system in the United Kingdom, the technology is required to obtain Home Office Type Approval (HOTA), involving a stringent testing of the technology. At the time this project was conducted, only two manufacturers of point-to-point speed enforcement systems had acquired type approval: Vysionics (formerly Speed Check Services) and Redspeed[23]. Vysionics has two systems: 'SPECS1', which was approved in 1999; and 'SPECS3', the improved version which was approved in more recent years. Redspeed produces a system known as 'RedFusion', which received type approval at the

[23] Stakeholders reported that multiple manufacturers are applying for HOTA, which will create a more competitive marketplace for consumers.

same time as the SPECS3 system. The SPECS3 systems utilise a distributed system (e.g., multi-point to multi-point), with back-office servers being able to process thousands of cameras.

As outlined in Figure 5.2, safety camera programs across England (indeed, across the entire United Kingdom) are operated at the county level by specific safety camera partnerships made up of relevant stakeholders (e.g., Police, the local highways authorities, Her Majesty's Court Services, the Highways Agency). As such, there is not one single organisation that consolidates all information relating to each of the separate partnerships. As a result, it is difficult to ascertain the precise number of point-to-point systems currently in use in the United Kingdom, particularly given the fact that the majority represent temporary installations of the technology.

Vysionics reported having operated over 210 temporary point-to-point systems in major roadworks schemes, as well as 36 permanent installations in the United Kingdom, including in England, Scotland, Wales and Northern Ireland[24]. Table 5.13 provides a list of the locations where permanent systems are currently located. In addition to these sites, there are typically between 15 and 40 temporary systems deployed for use in roadworks zones. The average length of SPECS systems is nine kilometres. The longest stretch of road enforced is on the A14 in Cambridgeshire, which was installed in 2007 utilises 28 cameras over a 22.4 kilometre stretch, and has been recently extended. The shortest length enforced is the Tower Bridge installation at 300 metres.

In addition to the SPECS systems outlined above, there are two permanent installations using Redfusion systems. The most extensive example of this is on the A13 in East London. The multi-point system is situated near the location where the Olympics will be held in 2012 and involves 85 cameras (at 37 different locations) covering every lane and every entry and exit point along a six mile stretch of road with three different speed limit zones. The longest individual section within the overall system is approximately four miles. A Redfusion system is also located on Victoria Way in Manchester in a residential area. In addition, temporary mobile Redfusion systems have also been used relatively extensively in roadworks zones (including tunnels) for periods ranging from one month to two years.

The majority of installations involve bi-directional systems. Systems have been installed on a large variety of road types including urban and rural roads, single and dual carriageways, and on roads with speed limits ranging from 30mph to 70mph.

The London Safety Camera Partnership also reports, via their website, a number of trial sites for new system manufacturers. These sites are undergoing a research and development phase as new manufacturers attempt to achieve HOTA, and thus are not enforceable. Specifically, in addition to a permanent installation pending for the A52 in Lincolnshire, the trial sites include:

- Mansfield Road to Gordon House Road, Camden – the system involves three entry and exit points and has been developed by Vysionics
- Salter Road, Southwark – the system involves a single entry and exit point trial and is trialling equipment developed by PIPS Technology to enforce a 20mph speed limit in an urban area

[24] At the time of this project, SPECS systems had not been installed outside of the United Kingdom.

- A102 Blackwall Tunnel – the system involves a single entry and exit point, monitoring average speeds along the northbound section of the tunnel. The system has been developed by RedSpeed International.

There has also been a recent shift towards trialling the use of point-to-point speed enforcement systems on low-speed urban routes (e.g., 20mph zones). It has been argued that the technology provides an effective alternative to traffic calming devices which are relatively expensive, can increase emissions and cause unnecessary disruptions for emergency vehicles (Crawford, 2009).

To encourage compliance on longer stretches, camera sites are typically spaced two to three kilometres apart. Such a practice is argued to increase the perception that monitoring equipment is in use approximately every five minutes and reduce the incentive to avoid entry and exit locations, given that motorists are unaware which links are currently activated. In addition, there are typically limited opportunities for access and egress. While it is not legislated to have contiguous enforcement corridors at these distances, it is a policy recommendation. The new generation systems are installed to cover all entry and exit points and can distinguish vehicle entry and exit points.

Initially, point-to-point speed camera installation criteria were recommended by the Department for Transport (DfT) under the Handbook of Rules and Guidance for the National Safety Camera Programme for England and Wales for 2006/07. These criteria are that locations must have had a minimum number of KSI (killed or seriously injured) collisions per kilometre in the past three years and 85th percentile speeds above the national enforcement threshold. In addition, it must be assessed that no other, more appropriate and cost-effective, engineering measure could mitigate the problem. While some partnerships still use that criteria, other criteria have been developed more recently (e.g., as an engineering solution to ensure speed limit compliance; to protect workers on long stretches of roadworks on motorways and dual carriageways). Some partnerships also stipulate that a particular number of KSI crashes must be speed-related, further highlighting the link between the purposes of the technology and improved safety.

Stakeholders reported a number of considerations for deciding the exact location of cameras, once an appropriate section of road had been identified. Specifically, given the location of other services beneath the road surface or verge (e.g., gas mains, water pipes), difficulties might be encountered when identifying the exact location to dig a hole for the foundation of the camera infrastructure. This was reported to be particularly problematic in more urbanised areas.

Table 5.13: Location of permanent point-to-point speed enforcement systems in England[a].

Road Section	County	Installation date[b]	Length[b]	Road Type[b]	Speed Limit[b]	Type of system[b]	Bi-directional[b]	Cameras[b, c]
A46 Cotgrave	Nottinghamshire	Jan 2006		Urban, single carriageway	50mph	SPECS[d]	Yes	4 pairs
A46 Fosse Road	Nottinghamshire	Feb 2002		Single carriageway, 2 lanes	40pmh	SPECS[d]	Yes	1 pair
A52 Bingham	Nottinghamshire	Jan 2006			50mph	SPECS[d]	Yes	2 pairs
A52 Holme Pierrepont	Nottinghamshire	Jan 2006		Rural, single carriageway, 2 lanes	NSL[e]	SPECS[d]	Yes	1 pair
A52 Radcliffe Road	Nottinghamshire	Jan 2006		Rural, single carriageway, 2 lanes	30mph	SPECS[d]	Yes	1 pair
A52 Saxondale Road	Nottinghamshire	Jan 2006		Rural, single carriageway, 2 lanes	NSL[e]	SPECS[d]	Yes	1 pair
A60 Mansfield Road	Nottinghamshire	Dec 2008	1 km	Urban, single carriageway, 3 lanes	30mph	SPECS3	Yes	1 pair
A60 London Road	Nottinghamshire	Dec 2010	0.5 km			SPECS3		1 pair
A631 Mill Hill Gringley	Nottinghamshire	Jan 2005	2 km	Single carriageway, 2 lanes	50mph	SPECS1	Yes	1 pair
A631 Scaftworth	Nottinghamshire	Mar 2005	1.5 km	Single carriageway, 2 lanes	50mph	SPECS1	Yes	1 pair
A631 Beckingham Bypass	Nottinghamshire		3 km			SPECS3		1 pair
A610 Nuthall Road	Nottinghamshire	Aug 2000	1.5 km	Urban	30mph	SPECS3	Yes	5 pairs
A6514 Ring Road (Valley Road, Western Boulevard, Middleton Boulevard)	Nottinghamshire	July 2002	6.4 km	Urban	40mph	SPECS1	Yes	11 pairs
B6004 Oxclose Lane	Nottinghamshire	Apr 2008	1 km	Urban, dual carriageway, 4 lanes	40mph	SPECS1	Yes	1 pair

Road Section	County	Installation date[b]	Length[b]	Road Type[b]	Speed Limit[b]	Type of system[b]	Bi-directional[b]	Cameras[b, c]
B6004 Arnold Road	Nottinghamshire	Feb 2004	2.5 km	Urban, single carriageway, 2 lanes	30mph	SPECS1	Yes	5 pairs
B6004 Edwards Lane	Nottinghamshire	Mar 2004	1 km	Urban, single carriageway, 2 lanes	30mph	SPECS1	Yes	1 pair
A611 Derby Road	Nottinghamshire	Jan 2010	1 km			SPECS1 & SPECS3[f]		1 pair
A616 Stocksbridge Bypass	South Yorkshire	Dec 2002	11 km	Urban, dual carriageway	40mph	SPECS[d]	Yes	8 pairs
A43 Lumbertubs Way	Northamptonshire	Nov 2002		Urban, dual carriageway	50mph	SPECS[d]	Yes	4 pairs
A428 Brayfield to Yardley Hastings	Northamptonshire	Apr 2004		Rural, single carriageway	60mph	SPECS[d]	Yes	1 pair
A14 Huntingdon to Cambridge	Cambridgeshire	Mar 2007	22.4 km	Dual carriageway	NSL[e]	SPECS1	Yes	5 pairs
A14 Girton to Fen Ditton	Cambridgeshire	Mar 2011				SPECS3	Yes	1 pair
A127 Arterial Road	Essex	Jan 2009				SPECS[d]		
A130 Canvey Way	Essex	Apr 2009				SPECS[d]		
M25 QEII Bridge (Jn 31)	Essex	Apr 2009				SPECS[d]		
A228 Isle of Grain	Kent	Nov 2006	7 km	Rural, single carriageway	40mph	SPECS[d]	Yes	
Upper Thames Street	City of London	Dec 2010		Urban		SPECS[d]		
Tower Bridge	City of London	Dec 2010		Urban, Bridge	20mph	SPECS[d]	Yes	1 pair
Blackwall Tunnel	City of London	Dec 2010		Urban		SPECS[d]		
A13	East London	Jan 2011	9.6 km	Urban		Redfusion		85 cameras[g]
M3 Jn 2 / M25 Jn 10	Surrey	Feb 2009				SPECS[d]		
M25 Dartford Tunnel Appr. (Jn 1)	Dartford	Dec 2010			50mph	SPECS[d]	Yes	
M60 Jn 24/25	Greater Manchester	Apr 2007				SPECS[d]		
Victoria Way	Manchester	Unknown		Residential area		Redfusion		

Road Section	County	Installation date[b]	Length[b]	Road Type[b]	Speed Limit[b]	Type of system[b]	Bi-directional[b]	Cameras[b, c]
A149 Sutton to Potter Heigham	Norfolk	Apr 2010				SPECS[d]		
A38 Bassetts Pole	Staffordshire	Apr 2011				SPECS[d]		
A38 Saltash Tunnel	Devon/Cornwall	Aug 2003		Tunnel	30mph	SPECS[d]	Yes	
A52 Ropsley	Lincolnshire							
A66	Bass Lake	Jan 2010				SPECS[d]		
B1096 Forty Foot Drain	Ramsey					SPECS3	Yes	1 pair
Seymour Road	Gloucestershire				20mph	SPECS[d]	Yes	
Podsmead Road	Gloucestershire	Aug 2001		Urban, single carriageway	30mph	SPECS[d]	Yes	6 pairs
M6 Jn 8 (Rayhall Viaduct)	West Midlands				40mph	SPECS[d]	Yes	
A537 Macclesfield to Buxton	Derbyshire	Jan 2010				SPECS[d]		
A374 Plymouth East End Transport Scheme	Plymouth	May 2011				SPECS[d]		
A3 Hindhead Tunnel	Hindhead	Jul 2011		Tunnel		SPECS[d]		

a. It was not feasible to contact every safety camera partnership within the United Kingdom. This Table represents information from a number of sources: (1) major safety camera partnerships and road safety organisations consulted; (2) consultations with Vysionics and RedSpeed International (the two most popular point-to-point speed camera manufacturers and providers in the United Kingdom); (3) website searches of all safety camera partnerships listed on the Highways Agency website; and (4) findings of the literature review.
b. Some information missing due to lack of reporting.
c. One pair of cameras represents a basic system with only entry and exit points. Multiple pairs of cameras represent either a system with additional camera sites between the entry and exit camera sites, or two separate systems on the same length of road.
d. These systems are SPECS systems, but it is unclear whether they are SPECS1 or SPECS3.
e. National Speed Limit. Differs by vehicle and road type.
f. Northbound uses SPECS1, while Southbound uses SPECS3.
g. Multi-point system. A total of 85 cameras installed at 37 locations. Each camera/lane connected to every other camera/lane.

5.2.14.2 Technological characteristics

As a starting point, it is useful to explain the key differences between the older SPECS1 systems and the newer SPECS3 and Redfusion systems. Specifically, SPECS1 systems were required to be hardwired from beginning to end, such that fibre optic cabling is used to connect the camera at the entry point to the camera at the exit point[25]. Given the costs associated with this communication network approach, most systems could only effectively enforce one lane at a time. Stakeholders reported that to maximise the deterrent impact of the systems, the activated cameras/lanes were randomly selected and changed regularly (e.g., swapped the combination of activated cameras/lanes around). Conversely, newer systems are not hardwired and involve a distributed system (e.g., multi-point to multi-point), with back-office servers being able to process many cameras and each entry and exit combination being able to be contiguously enforced.

The number of cameras and camera sites used within each system depends on the length of the monitored road. However, cameras typically operate as separate pairs of cameras, even in situations involving contiguous enforcement corridors (similar to the Victorian systems explained in Section 5.1.1). Generally, both directions on the enforced sections are monitored. Both forward- and rearward-facing cameras are used, however forward-facing cameras are more common given that they allow for driver identification and typically produce better readability rates. It was reported that SPECS1 systems involve rearward-facing cameras while SPECS3 systems utilise both. The use of rearward-facing cameras was noted for locations with a motorcycle speeding problem, such as on the A611 Beckingham Bypass.

While a designated camera is used for each lane, the oblique view captured means it is rarely necessary to have one camera per lane at all sites (e.g. two cameras appearing to view three lanes). While many of the newer systems have the technological capability to capture instantaneous speeds, at the time this project was conducted the cameras were not being utilised for this purpose.

Permanent systems are typically mounted on roadside cantilevers (very recognisable – see Figure 4.3), however a number of systems have also been installed on existing infrastructure including gantries and bridges/overpasses. Stakeholders reported that compliance is noticeably higher in association with stand-alone cantilever columns. Conversely, the mounting of mobile/temporary systems depends on the projected length of roadworks associated with the installation. For medium to long term roadworks, a standard cantilever column is used, which can have a semi-portable foundation, while shorter installations use a rapid deployment column which is mechanically wound up to height, and rests on a wheeled base. Stakeholders highlighted very few issues associated with vandalism or tampering with equipment, reporting only two instances of vandalism[26] from over 240 installations. The physical size and location of the camera arms is argued to account for the low level of vandalism experienced.

Table 5.14 provides a comprehensive overview of the technological characteristics of point-to-point speed enforcement systems in England.

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[25] For example, on a two-lane section of road, cabling would be required to connect lane one at entry to lane one at exit, lane two at entry with lane two at exit, then lane one at entry to lane two at exit and finally lane two at entry with lane one at exit.

[26] One column was cut down with an angle grinder. One column was doused with petrol and set alight. Other stakeholders also reported minimal vandalism, including fibre optic cables being cut and equipment set on fire.

Table 5.14: Technological overview of point-to-point speed enforcement systems in England.

System Component	Specific Characteristics
Cameras & Illumination	
Number of cameras	Depends on length of enforced site/number of camera sites
Number of camera sites	Depends on length of enforced site
Camera resolution	PAL video resolution (older systems); 1.4 Megapixels (Redfusion system)
Digital or analogue	Analogue (older systems); Digital systems (newer systems)
Monochrome or colour	Both. Monochrome (ANPR) camera and colour overview camera
Camera activation	Continual video streaming (older systems); laser triggering of each lane (Redfusion)
Forward or rearward facing	Both – although forward facing more common
Camera per lane or multiple lanes	Designated camera per lane[a]
Illumination approach	Infra-red or white light
Infrastructure	
Camera mounting approach	For permanent systems = Typically on roadside cantilevers (6 metres high and 3 metre cantilever arms), but also on gantries and over bridges. For temporary systems = roadside cantilever with semi-portable foundation (medium/long term roadworks) or rapid deployment column, mechanically wound up to height, on a wheeled base (very short term installations)
Purpose built or existing	Typically purpose-built, but sometimes utilising existing infrastructure
Camera housing approach	Standard CCTV type enclosures; weather, tamper and vandalism-proof; tested to IP 55
Power source	AC mains (230-240V) – (generators can also be used but are not recommended)
System Software & Processors	
Software characteristics	SPECS uses ANPR software[b] ; RedFusion uses bespoke software for its operation with a core of Microsoft's XP embedded - ANPR uses two third party software packages
Matching approach	SPECS: most systems use structural analysis and an expected plate format; Redfusion: template matching with an intelligent algorithm
Location of processor	Roadside within the local cabinet
System hardware	Industrial PCs and custom boards
Clock synchronisation	GPS from two independent checks (primary method is an internal timing source, secondary method is an independent national or crystal clock); if the two clocks are outside a configurable set difference the system suspends enforcement
Size and type of image data file	Older systems = Offence file <1MB; contains four images (entry & exit ANPR and entry & exit overview) with a file format that is unique to SPECS. Redfusion = JPEG 500kB (each image – one monochrome and one colour), typically a 70% compression is used
Data storage approach	SPECS1 = WORM disk in local cabinet captures offence files. SPECS3 = encrypts data before sending it to remote in-station (carried out to AES standard), which determines if an offence has been committed (from journey time) before requesting images of offending vehicles. Redfusion = data is written in encrypted form to a worm drive. Stored data is deleted once transmitted or deleted after a pre set period of time if transmission is not successful. All systems = Only images of offenders are kept
Communications Network & Back Office	
Communication network approach	SPECS: Once encrypted, any public communications network can be used; typically fibre optic cables are used for SPECS1 systems and ADSL for SPECS3 systems; Redfusion: 3G, Ethernet, satellite or microware communications. The encrypted data on the WORM drive is imported to the back office database (secure Microsoft SQL server database which can either be configured for windows authenticated access or Secure Login) and is stored in encrypted form in the database and decrypted 'on the fly' when the details are required for the back office screen or export to third party Violation Processing systems
Information captured by system	Vehicle Registration Mark (VRM), primary and secondary time and site location, images at entry and exit points, capture speed, camera head and exit number
Degree of back-office automation	Manual verification of all infringements

a. However, given the fibre optic cabling approach adopted with older systems, many only link one pair of cameras across a section (e.g., not all lanes monitored at the one time on multi-carriageway roads). *b. Specific characteristics of the software and accompanying software differ depending on the systems employed.*

5.2.14.3 Operational characteristics

As stated in Figure 5.2, safety camera programs, including point-to-point speed cameras, are operated and managed by safety camera partnerships, involving the local highways authorities, Her Majesty's Court Services and the Highways Agency. These partnerships exist at a county level and are largely separated from one another. Specifically, local Governments typically manage the highway network and are responsible for installing and maintaining permanent enforcement systems, while the Police are responsible for undertaking the enforcement and administration of infringement notices and the HMCS are responsible for receiving payments of fines. However, the level of involvement of each partner varies across the United Kingdom.

Permanent systems are operated and managed by the speed camera partnerships, while temporary systems used in roadworks zones are leased from the supplier for the duration of the work by the roadwork contractor and managed by the safety camera partnership. The police force for the jurisdictions (e.g., county) are responsible for the administration of infringement notices, with roadwork contractors required to provide daily signage audits (e.g., detailing the speed limit through the roadworks zone) to the police for evidential purposes.

Annual maintenance schedules and calibration requirements exist for the systems. In addition, general cleaning and inspection is typically conducted every three to six months, or quarterly in relation to Redfusion systems. To ensure synchronisation, two separate clocks are used. When a discrepancy is identified the offence is negated and the system is inspected.

A number of signage requirements exist. Firstly, a Traffic Regulation Order (TRO) must be obtained specifying the speed limit and the length of the speed limit zone. Temporary TROs are available for roadworks. Co-located 'Average Speed Camera' signs and reminder speed limit signs should be located within line of sight of the cameras, and are situated prior to the enforcement section. In addition, repeater signs are typically located throughout the enforcement corridor, particularly longer stretches. Daily audits are conducted to ensure appropriate on-going signage of the enforcement area and it is critical that the speed limit is correctly signed. Finally, signs are generally used prior to the activation of point-to-point cameras to inform motorists that the equipment is being tested.

Earlier systems were capable of enforcing only a single speed limit. While the newer generation technology is capable of conducting enforcement over non-discrete speed limit zones, such an approach is not typically employed given that it substantially increases costs associated with back-office processing.

In the United Kingdom, point-to-point systems can only be used for one purpose at a time, even though they have the technical capability to be used for multiple purposes. In the case of the A13 system in London, it was reported that, during the Olympics in 2012, the speed enforcement function will be temporarily ceased while the cameras are used for broader security purposes. Nonetheless, when the system is being used for the purposes of speed enforcement, if a vehicle is detected committing an offence, the vehicle registration data can be used to check for the insurance and registration of the vehicle. However, registration details of non-offending vehicles cannot be checked.

5.2.14.4 Legislative characteristics

Prior to the use of any enforcement system in the United Kingdom, the technology is required to obtain HOTA, involving a stringent testing of the technology. As part of the type approval, all systems are required to have a secondary method of determining speed which is independent to the first. In the instance of point-to-point systems, most manufacturers use two independent clock systems within the camera system itself. Type approval requires that these clocks be calibrated once a year, with the calibration undertaken by the manufacturer.

Type approval also requires the measurement of shortest practicable distance between two cameras. The exact method used to assess this distance differs by jurisdiction. One approach involves a vehicle with an on-board device driving the route a number of times along the ‘racing lines’, with the shortest distance of all trips taken. Another approach involves the use of a calibrated wheel which measures the shortest distance between camera sites. In the past, highly accurate GPS measurement systems have also been used. The manufacturer is also responsible for this process.

Stakeholders reported that the type approval process can be very lengthy. Indeed, Vysionics (formerly SCS), which is the supplier of SPECS systems, reported that this process took seven years for SPECS1 and five years for SPECS3.

Once type approval is achieved, strict checks are regularly carried out to ensure compliance with that approval. Any changes to equipment (e.g., change in software or hardware) require further approval processes to ensure continuing compliance. In addition, each system must be installed to meet local safety criteria, which varies from county to county.

After installation the system undergoes a ‘setting to work’ schedule, carried out by the supplier, to ensure all component parts are fully operational and electrical interfaces are compliant. Once this process is completed, a calibration certificate is produced identifying the surveyed distance between camera sites in the system. Annual calibration of equipment is required and whenever a change in the road layout occurs between the enforced section further calibrations are required. Temporary average speed cameras are normally placed on road work sections where the topology of the road may change, dependant on the work being carried out. If the work affects the enforcement section then a further calibration will be required as the distance between cameras may have changed. It is important that any change in road layout results in a re-calibration.

In the United Kingdom, the onus is on the vehicle owner to provide details of the driver at the time of the alleged offence. Moreover, it is an offence not to provide this information within 28 days, attracting a £2 500 fine and the loss of six demerit points. Higher penalties exist for companies who do not nominate drivers within their fleet. For multipoint-systems, a multiple infringement policy exists whereby only the highest offence committed by an individual during a single journey through an enforced section is prosecuted.

In the United Kingdom, the Association of Chief Police Officers (ACPO) recommends that enforcement is conducted with a threshold equivalent to 10% of the speed limit plus 2mph (e.g., 57mph in a 50mph zone)27. It was reported the 10% leeway is a legal requirement, while the additional 2mph is an ACPO policy requirement. However, in situations whereby the number of offences detected results in congestion in back office processing of the infringements, there are policies to adjust the threshold to alleviate throughput difficulties.

[27] Enforcement carried out by traditional methods may be carried out at officer discretion even though guidance recommends 10% +2. Each chief constable has the final say in what thresholds are used.

The enforcement tolerance employed must meet the Home Office standard. Stakeholders reported that there had been no formal discussion relating to applying a lower enforcement tolerance to offences in association with point-to-point.

5.2.14.5 Broader issues

Broader speed management issues: Numerous enforcement strategies are adopted in the United Kingdom to address speeding behaviour, including instantaneous speed cameras, combined speed and red light cameras, mobile speed cameras and more traditional approaches such as handheld and moving-mode radars and routine patrols. Variable speed limit (VSL) and driver speed message signs are also used, however not in conjunction with cameras. Fixed cameras are used relatively extensively, with the majority involving wet-film cameras, with housings populated at a rate of approximately 1:4 to 1:10 (e.g., cameras deployed within a myriad of sites).

Stakeholders reported that, in some partnership areas, point-to-point speed cameras represented approximately one-third of all fixed speed camera operations. It was noted that many wet-film fixed speed cameras were becoming redundant in association with a cessation of the production of the film used in the United Kingdom. As a result, stakeholders noted that point-to-point camera systems are likely to gain further acceptance and be installed in place of instantaneous fixed speed cameras, given that they achieve compliance over a larger area.

Safety camera partnerships are responsible for the operation and management of point-to-point speed enforcement systems. Partnerships are unique entities, each with their own enforcement strategies. While many of these strategies are based on the DfT guidelines issued between 2004 and 2006, partnerships have been free to adopt strategies outside of these guidelines since 2007.

Stakeholders reported a number of advantages associated with point-to-point speed enforcement. It was argued that, when intelligently applied to a section of road, the approach delivers benefits over a larger area compared to other automated approaches to speed enforcement. The key advantages were reported to include: vastly improved compliance with speed limits; reduced vehicle speeds; reduced traffic crashes; smoother traffic flows, improved journey reliability and reduced congestion (particularly in roadworks zones); reductions in vehicle emissions; less susceptible to vandalism; cheaper back office costs if used correctly (e.g., regionalised role); and, that the approach is typically perceived to be a fairer speed enforcement method by motorists. It was also noted that networks of cameras can be installed over time, phasing equipment in as funds allow.

Disadvantages included that older systems were expensive to operate. It was reported that a number of partnerships are currently encouraging trials of additional systems seeking type approval in the hope that an increase in the number of system manufacturers will create better competition in the market place and reduce the associated costs.

The specific use of the systems was argued to be critical. While it was acknowledged that a system could be developed to monitor every single vehicle and journey on a section of road, such a system would penalise a large number of drivers even when compliance is high. Instead, it is suggested that a relatively low-level enforcement regime be employed, such that different sections can be made active at different times. It is argued that such an approach increases public and political acceptability, ensuring the integrity of the systems without being seen as a revenue raiser, and maintaining all the benefits associated with the technology.

Public education: Stakeholders highlighted the need for the motoring public to be informed of how point-to-point systems operate. They suggested that highlighting the fairness of measuring average speeds would be beneficial, such that it allows motorists additional leeway by providing them with time to reduce their speed. It was argued that a comprehensive media campaign prior to the implementation of a point-to-point system is all that is required to inform motorists. It was reported that publicity campaigns typically explain why the technology is being installed in the specific location (to increase perceived legitimacy) and how the systems operate (to increase acceptance). Previous campaigns have involved radio, television and newspaper advertisements and leaflets distributed to each property within the area, as well as general press releases and encouragement for local media to report on the new systems.

It was noted that a number of systems had previously been installed without a corresponding media campaign, and in such instances motorists quickly identified their use and how the systems operate. However, it was typically argued that motorists more readily accepted point-to-point cameras when their installation is accompanied by a media campaign, resulting in maximised rates of compliance.

Evaluation: A limited number of independent studies have been conducted (see Section 3 for a detailed overview of this research, as well as studies conducted by Vysionics/SCS). Stakeholders reported that many partnerships collect pre and post-implementation crash and speed profiles. In addition, many also conduct public perception surveys.

5.2.15 Scotland & Northern Ireland

There are also a number of point-to-point speed enforcement systems currently in use in Scotland and Northern Ireland. These systems are all provided by the United Kingdom based manufacturer Vysionics (formerly Speed Check Services), with the Scottish systems employing SPECS1 technology[28]. Unfortunately, no stakeholder organisations from Northern Ireland were able to participate in the current research. Thus, with the exception of outlining the extent of use of the technology in the country, all discussions in the following sections relate only to those point-to-point systems operating in Scotland.

5.2.15.1 Extent of use of point-to-point speed enforcement

In Scotland, there is currently one permanent point-to-point speed camera system located on a 51.5 kilometre stretch of the A77 in Strathclyde between Bogend Toll and Ardwell Bay. The section of road is a rural highway including both single and dual carriageway sections, with a national speed limit setting. The cameras were first implemented along the stretch in July 2005 and involve a total of 40 linked cameras at 15 sites monitoring speeds over the section of road (in both directions), with individual sites ranging from 1.3 to 8.9 kilometres apart. Pairs of cameras operate periodically and due to the inconsistent speed limits along the section, average speeds are *not* measured across contiguous sections or over the entire route. In addition to this fixed site, Transport Scotland also utilises temporary point-to-point systems at a number of roadwork sites. Currently, only one temporary system operates in the country, along the A80/M80, and has been used since November 2009, although the technology has previously been used at half a dozen additional roadworks sites throughout the country.

[28] It was unclear from consultations whether the systems operated in Northern Ireland are SPECS1 or SPECS3.

Given the length of the site on the A77 there are inevitably opportunities for vehicles to enter and exit the system. However, the cameras have been located at key strategic points to ensure that a large majority of vehicle journeys occur between camera poles. On the A77, various speed limits, ranging from 30mph in built-up areas to the national speed limit (max. 70mph) on dual-carriageway sections, are effective throughout the enforcement corridor. A limited number of Vehicle Activated Signs (VAS) are used to remind speeding drivers of the speed limit. In addition to the A77 system, a number of temporary point-to-point speed camera systems (SPECS) have also been used or are currently in use. Indeed, the first implementation of the technology in Scotland was during roadworks on the M74 Raith Interchange from February to June 2006. The approach has been used at various roadworks sites since that time, most recently on the A80/M80 Stepps to Haggs improvement scheme.

There are also two permanent point-to-point systems operational in Northern Ireland, the first of which was implemented in July 2006 (A1 Newry) and the second in March 2008 (A2 Belfast to Bangor). Both systems are located on rural highways that include both single and dual carriageway sections, with a national speed limit setting. Table 5.15 outlines the locations of all current point-to-point speed enforcement systems in Scotland and Northern Ireland.

Table 5.15: Locations of point-to-point speed camera systems in Scotland & Northern Ireland.

Location	Road section	Date	Details
Scotland			
Strathclyde	A77 Ayr to Stranraer	Jul 2005	Permanent, 51.5 km stretch, national speed limit[a], rural, single and dual carriageway sections, bi-directional, 40 cameras at 15 locations
Stepps to Haggs	A80/M80	Nov 2009	Temporary system during roadworks
Northern Ireland			
Northern Ireland	A2 Belfast to Bangor	Mar 2008	Permanent, 14.8 km stretch, national speed limit[a], rural, single and dual carriageways
Northern Ireland	A1 Newry	Jul 2006	Permanent, national speed limit[a], rural, single and dual carriageways

a. National Speed Limit. Differs by vehicle and road type.

All safety cameras in Scotland are operated under the rules of the Scottish Safety Camera Programme, a national, evidence-based crash reduction initiative funded by the Justice Department of the Scottish Government. There are strict criteria to be met for selection of safety camera sites, which include: a history of serious injury crashes; evidence of prevalent speeding; and, no viable alternative road engineering solutions being available. Roads authorities and police must also agree that the use of the safety cameras are limited to practical locations and are likely to be effective in reducing crashes and casualties. These rules ensure that the resource is targeted most effectively on the areas of greatest need.

The permanent system on the A77 was introduced in 2005 on the basis of a long history of fatal and serious crashes occurring along the enforced stretch. In the five years prior to the installation of the cameras, the route had experienced 20 fatalities and 95 serious injuries as a result of traffic crashes. All temporary operations in Scotland have been installed during major roadworks in the area, and were introduced to encourage compliance with reduced speed limits in place during these works and to aid motorist and worker safety. These temporary sites were selected on a case-by-case basis once sufficient justification was provided from the contractor carrying out the roadworks.

5.2.15.2 Technological characteristics

As stated above, the A77 system involves 40 linked cameras across 15 locations. Designated cameras monitor each lane, with the number of cameras at any single location therefore dependent on the number of lanes being monitored. Only forward-facing cameras are used, which are installed using purpose-built poles located on the roadside or central reservation. The poles are highly visible (yellow or blue) to ensure that they are very noticeable to anyone driving along the road.

The system use fibre-optic cables embedded in the road surface to communicate data between camera units, however it was noted that any future systems would use wireless technology (e.g., SPECS3 upgrade).

Data relating to vehicles caught exceeding the speed threshold are saved to a roadside processor, with data periodically transferred onto a WORM disc and then transferred to the back-office for processing. The use of the WORM disc and a stand-alone back-office PC creates an ‘air gap’ between the offence and its processing, and thus security protocols have been developed and must be adhered to.

The stakeholders reported that several years ago they had an incident where someone attacked the system at the base of the pole and set fire to the installations. Since then the manufacturer has upgraded the security of the poles base panel to prevent similar occurrences from happening.

Table 5.16 provides a comprehensive overview of the technological characteristics of point-to-point speed enforcement systems in Scotland.

5.2.15.3 Operational characteristics

Similar to the rest of the United Kingdom, the A77 system is operated and managed by a safety camera partnership; specifically the Strathclyde Safety Camera Partnership. The partnership, consisting of local council, police and other stakeholders, is responsible for the day to day operation and servicing of the system, as well as the processing of offences (police). In addition, the manufacturer (Vysionics) is responsible for the repair and maintenance of the system. However, Transport Scotland maintains ownership of the system and is responsible for all trunk roads (major roads) in Scotland and ultimately is responsible for the system.

An annual maintenance schedule exists, whereby Vysionics maintains, repairs and calibrates the system throughout the year. This agreement exists in corroboration with Transport Scotland. In addition to the maintenance schedules, if day-to-day difficulties with the system are encountered, the manufacturer is contacted and provides an ‘on-site’ technician to rectify the issue.

The Safety Camera Partnership is only able to access data relating to vehicles recorded travelling in excess of the speed threshold. The images and data are uploaded to the offence processing system (EROS2), in addition to offences recorded from other camera types. The registration details of the vehicle are then checked by the offence processing staff using the Police National Computer database in order to determine the registered owner of the vehicle. If requested, the manufacturer can provide the police with a list of all vehicles that have passed through the system on a particular date, regardless of whether or not a speeding offence had occurred, to be checked against criminal databases if a serious crime is being investigated.

Table 5.16: Technological overview of the A77 point-to-point speed enforcement system in Scotland.

System Component	Specific Characteristics
Cameras & Illumination	
Number of cameras	40 linked cameras (2 or 4 camera units at each location depending on the number of lanes)
Number of camera sites	15 camera sites
Camera resolution	N/A
Digital or analogue	Digital
Monochrome or colour	Both. Monochrome (ANPR) camera and colour overview camera
Camera activation	N/A
Forward or rearward facing	Forward-facing
Camera per lane or multiple lanes	Designated camera per lane (can also monitor cross-lane vehicle movements)
Illumination approach	Infra-red
Infrastructure	
Camera mounting approach	Most commonly mounted on poles installed at the roadside or in the central reservation (camera heads mounted at the top of these poles and over-hang the road slightly). Cameras located at temporary roadworks sites mounted the same way
Purpose built or existing	Purpose built
Camera housing approach	Standard CCTV type enclosures; weather, tamper and vandalism-proof
Power source	AC mains (230V)
System Software & Processors	
Software characteristics	ANPR software
Matching approach	Structural analysis and an expected plate format
Location of processor	Roadside within the local cabinet
System hardware	Industrial PCs and custom boards
Clock synchronisation	GPS from two independent checks; national clock
Size and type of image data file	Offence file <1MB; contains four images (entry & exit ANPR and entry & exit overview) with a file format that is unique to SPECS
Data storage approach	WORM disk in local cabinet captures offence files and is removed periodically and transferred to back-office PC by staff. Only images of offenders are kept
Communications Network & Back Office	
Communication network approach	Fibre-optic cables embedded in the road surface. Data is encrypted
Information captured by system	Vehicle registration mark, location, date/time passing each camera, images at entry and exit points, capture speed
Degree of back-office automation	Manual verification of all infringements

5.2.15.4 Legislative characteristics

The operation of all safety cameras in Scotland is overseen by the Scottish Safety Camera Programme, part of the Scottish Government. The Strathclyde partnership receives an annual grant to provide camera enforcement in their designated counties. Camera sites must be approved by the Scottish Safety Camera Programme prior to implementation. Prior to seeking approval, initial agreement must be reached between the Strathclyde Safety Camera Partnership, Strathclyde Police and Transport Scotland (or the relevant local authority) that the use of safety cameras would be beneficial on the proposed section of road. Such decisions are evidence-based, with proposed sites chosen on the basis of analyses of crash, casualty and speed data. Similar to the rest of the United Kingdom, all camera systems must also pass the HOTA certification process.

Similar to other parts of the United Kingdom, it is the responsibility of the vehicle owner (or registered keeper) to inform the Police regarding who was driving their vehicle at the time of an alleged offence. If the registered keeper of a vehicle is unable to identify who was driving their vehicle at the time, or if they refuse to identify the driver, they can be charged with a separate offence of ‘failing to nominate’, which can lead to a higher penalty and fine.

There is no multiple infringement policy associated with the A77 system. Each separately recorded offence along the route is treated individually, given that the offences are committed on a different section of road. The system allows for a minor enforcement tolerance, similar to that adopted in association with other safety cameras across Scotland, so that offences are recorded at a threshold set slightly above the speed limit.

Legally, in Scotland, only the speed limit signage needs to be compliant with the Road Traffic Regulations in order for an offence to be acceptable. However, under the guidelines set by the Scottish Safety Camera Programme, the Strathclyde Safety Camera Partnership also ensures that adequate camera warning signs are located a few hundred metres prior to the commencement of an average speed site. A new sign type was introduced to the Road Traffic Regulations list of approved roadside signage when the A77 system was installed. The sign involved a camera pictogram and the text ‘Average Speed Cameras’ (black lettering on a white background).

In addition, the partnership encourages repeater camera warning signage throughout the duration of the system to remind drivers that they are still within an average speed enforced zone. Additional speed limit signage, including the use of vehicle-activated speed limit signs, is also installed throughout the enforcement corridor. The stakeholders noted that the aim of the system is to encourage compliance with speed limits to serve a road safety benefit, not to increase the detection of speeding motorists.

While the exact method used to survey the shortest practicable distance remained uncertain from the stakeholder consultations, it is likely that the approach is similar to that used in association with SPECS1 systems installed in England (see Section 5.3.1).

5.2.15.5 Broader issues

Broader speed management issues: The Strathclyde Safety Camera Partnership also operates a number of other types of speed enforcement equipment. These include: Gatso fixed speed cameras, RedSpeed fixed speed cameras, and mobile camera sites (enforced periodically by a highly visible van parked at the roadside). In total the partnership currently enforces at 67 fixed speed and 37 mobile camera sites, as well as at 25 red-light camera locations. Finally, Strathclyde Police also conduct routine traffic patrols around the force area, including both roadside and in-vehicle speed monitoring.

While the stakeholders acknowledged that only one permanent point-to-point system currently operates in Scotland, it was noted that the systems represents a significant length of road given that it monitors speeds over a 51.5 kilometre distance. Furthermore, it was noted that fixed cameras typically influence motorist behaviour for approximately one kilometre. Thus, it was argued that point-to-point speed enforcement performs an important role in the overall speed enforcement strategy for the area. Finally, it was noted that the use of point-to-point technology was expected to increase in the future given the success of the A77 system.

A number of advantages associated with point-to-point speed enforcement were reported. These included immediate and substantial impacts on vehicle speeds, exceptional rates of compliance, crash reductions, a more long-term impact on behaviour across a greater section of the road network and perceptions among motorists that the technology represents a fairer approach to speed enforcement compared to other automated technologies which capture speed at a single instantaneous point. Noted disadvantages included the relatively expensive nature of the technology, which was noted as a factor that restricted more widespread use of point-to-point speed enforcement systems across Scotland.

Public education: Stakeholders reported that, at the time the A77 system was installed, a working group was set up (the A77 Safety Group) to investigate the most appropriate method of promoting safe driving along the section of road. This group consisted of members from Strathclyde Police, Transport Scotland, Strathclyde Fire & Rescue, Westsound radio station and the Strathclyde Safety Camera Partnership. As part of the functions of the group, a number of advertising campaigns were developed with the objective of influencing motorist behaviour. In addition, the A77 system was launched by the Scottish Minister for Transport amid an extensive media campaign, which included considerable coverage in all local and national newspapers, as well as on national television (BBC and STV channels). The Safety Camera Partnership also promotes the system on its own website, where its location is marked on an interactive map (along with all other safety camera sites in Scotland).

The stakeholders noted the particular importance of public education in relation to the A77 system. Indeed, given that the system represented the first installation of point-to-point speed enforcement technology in the country, it was acknowledged that many motorists would be unfamiliar with how the cameras operated or how average speed was calculated. As a result, these aspects of the system were highlighted in the extensive media campaign. Moreover, it was noted that safety cameras often produce strong opinions from the motoring public (both positive and negative), and thus an open and transparent approach to the operation of the system was a critical objective. The stakeholders reported that public opinion surveys have shown that 70-80% of people support the use of safety cameras.

Evaluation: Evaluations of the A77 system are conducted yearly by the A77 Safety Group or Strathclyde Safety Camera Partnership. These evaluations are non-independent and typically focus on speed and crash reductions. Available data from these evaluations is presented in Section 3.

5.2.16 The Netherlands

5.2.16.1 Extent of use of point-to-point speed enforcement

The first country in the world to both trial and fully implement point-to-point speed cameras was the Netherlands. The impetus behind introducing the technology was two-fold: improving road safety and reducing congestion and emissions. In 1997, the approach was trialled on three sites along the A2 motorway between Maarssen and Breukelen totalling three kilometres (Malenstein, 1997). The first full implementation of point-to-point speed enforcement occurred on a two kilometre section of the A13 Overschie in May 2002 (Stefan, 2005).

The first permanent implementation occurred on a two kilometre section of the A13 Overschie, an urban motorway with three lanes in each direction and an estimated daily traffic volume of 124 000 vehicles, in May 2002. The installation represented a problem-oriented solution to complaints by local residents regarding increased vehicle noise and pollution. Specifically, the motorway, located in the highly-dense urban area, experienced a significant increase in traffic volume. As a result, the road layout was adapted to allow for greater traffic volumes; however the changes meant that the road was now closer to the homes of local residents. In response to the complaints associated with these road changes, the speed limit on the two kilometre section of road was reduced from 100 km/h to 80 km/h and a point-to-point speed enforcement system was installed.

There are currently 11 permanent point-to-point speed enforcement locations in the Netherlands (see Table 5.17). The enforced sections differ in length for each location, however there are fixed distances between camera sites. Specifically, the cameras (which are all fixed on the gantries of the motorway management system[29]) are located every 750-900 metres, or 300-400 metres on complex road sections. There are no opportunities for access or egress at any of the permanent locations.

Locations for the implementation of point-to-point speed enforcement are based on a number of criteria including a high incidence of traffic crashes, vehicle noise and emission problems (particularly at locations where motorways are situated adjacent to built-up urban areas) or where traffic calming is required.

Table 5.17: Location of permanent point-to-point speed enforcement systems in the Netherlands.

Road section	Details
A10 Orbital Motorway, Amsterdam	100 km/h
A12 Oudenrijn to Lunetten	Bi-directional, 80 km/h
A12 Lunetten to De Meern	Bi-directional, 100 km/h
A12 De Meern to Woerden	120 km/h
A12 Prins Clausplein to The Hague	80 km/h
A12 Velperbroek to Waterberg	100 km/h
A13 Berkel to Rodenrijs to Kleinpolderplein	Implemented May 2002, 2 km length, 80 km/h (reduced from 100 km/h), urban dual carriageway (6 lanes)
A20 Kleinpolder plein to Terbregse plein	80 km/h
N33 Provincial road, Noord Appingedam to Eemshaven	80 km/h
N62 Westerschelde tunnel	Tunnel, 100 km/h
N256 Provincial Road, Zeeland bridge	80 km/h

Stakeholders also reported that a pilot study was scheduled for late 2012 to trial the use of point-to-point speed enforcement in association with variable speed limits. Specifically, the systems will automatically adapt to the real-time speed limit, which will be communicated to

[29] The motorway management system is a series of overhead, gantry-mounted signs displaying both route navigation information, as well as speed limits on electric matrix signs.

motorists via matrix signs. Stakeholders also reported a number of additional locations where further implementation of point-to-point systems are pending, including: on the A2 Utrecht to Amsterdam; A4 The Hague to Amsterdam; A12 The Hague to Utrecht; N34 Emmen to Groningen; as well as ten mobile systems at locations in the province of Flevoland.

A mobile point-to-point system installed in police vans was trialled a number of years ago by the regional police agency of Flevoland, but was abandoned after a short while due to technical issues. System providers Pulnix and Addco have recently developed a new mobile system, which involves the same system components and architecture as the current permanent installations. The technology has been successfully tested at roadwork zones and type approval has been achieved. The distance between the cameras is fully variable and is calculated automatically by means of GPS and map matching.

5.2.16.2 Technological characteristics

The number of cameras and camera sites included in the systems differs based on the length of the system and the number of lanes monitored. Specifically, as stated in the previous section, camera sites are located at fixed distances within the enforcement corridor on the gantries of the motorway management system. The existing data communication infrastructure along the motorways is also utilised. In addition, designated cameras are used to monitor each individual lane, with rearward-facing cameras used in all systems and light detectors also attached to the gantry to adjust the cameras for the varying light conditions.

The systems involve a serial interface which communicates with the matrix system (which shows the motorist the speed limit) and GPS receivers are used to continuously check the time. If either of these components malfunctions, it is immediately detected and the system is deactivated until the problem is rectified. These system parameters are stored continuously in the fingerprint files, guaranteeing proper system functionality when a violation is detected and captured and subsequently ensuring infringements cannot be contested in court.

The roadside cabinets are also protected against tampering, such that unauthorised attempts to open the cabinets result in an immediate shut down of the system, with the hard disk erased immediately. Indeed, stakeholders reported no issues with vandalism, nor any attempts to hack the data communication network component of the systems.

In some instances, point-to-point systems in the Netherlands are fully automated, from the detection of the offence to the issuing of the infringement notice. Vehicle data are checked against the Ministry of Transport database and corroborated through vehicle length measurements via induction loops. Stakeholders reported that the accuracy of the vehicle matching process is 99.7%, with the accuracy of the ANPR processing slightly lower, at approximately 87%. Unrecognised number plates are stored in a separate database within the central processing unit of the National Police Agency and manually identified. If manual verification fails to ascertain the registration details of the vehicle, the entire file related to that case is destroyed. At the end of the entire process a hard-copy infringement notice is posted to the violator.

Stakeholders reported that the A13 system is supplied by Pulnix (a JAI technology subsidiary). While it is likely that all other permanent installations utilise the same equipment, this was unclear from the stakeholder consultation process. The stakeholders reported a number of system design improvements made by Pulnix, including: the consolidation of all camera and trigger processing equipment to reduce the number of individual elements and lower costs; the development of a faster and lower cost image processing card and other tools to simplify camera installation and reduce setup costs; developed error logging features, software debug tools, remote control and software update capabilities; and significantly increased and enhanced documentation.

Finally, stakeholders reported that the ANPR software is currently being modified to capture and read HAZMAT plates (hazardous materials). Initial trials were reported as being positive. It was argued that this feature would substantially enhance the possibility to recognise and monitor vehicles carrying hazardous materials and provides innovative methods for specific enforcement and incident management issues associated with vehicles carrying such materials.

Table 5.18 provides a comprehensive overview of the technological characteristics of point-to-point speed enforcement systems in the Netherlands.

5.2.16.3 Operational characteristics

In the Netherlands, the point-to-point speed enforcement systems are owned and operated by the Central Prosecutor for Traffic, who are also responsible for the maintenance of the systems. Conversely, the Central Processing Unit of the National Police Agency is responsible for processing infringements, which are then administered by a regional prosecutor's office or by the National Executive Authority (CJIB).

As reported above, many of the systems in the Netherlands are fully automated. Stakeholders reported that such systems are highly accurate, and thus the automated nature minimises operational costs associated with the system. Indeed, using the A13 system as an example, automated processing accounts for approximately 84% of offences. Conversely, approximately 125 offenders per day (16% of all daily violators) must be manually processed due to the unreadability of number plates by the system. The processing of infringements is conducted on existing platforms (e.g., those used for other camera detected offences), and therefore no extra staff are required.

In the Netherlands, it is a legislative requirement that motorists be warned, via the use of signage, that an enforcement method is being used. In addition, motorists must be consistently notified of current speed limits via the use of VSL signs or matrices. For the majority of point-to-point systems, these VSL signs are integrated with current infrastructure, such as overhead gantries which support navigational signage.

A 3% enforcement tolerance is afforded to motorists, with this leeway common to all speed enforcement approaches. In addition, a multiple infringement policy is in place to safeguard motorists from being fined several times across a single enforcement corridor. Currently, data collected by the systems are linked only to the license registration database; however the possibility of linking the systems to databases of stolen vehicles is under investigation.

Table 5.18: Technological overview of point-to-point speed enforcement systems in the Netherlands.

System Component	Specific Characteristics
Cameras & Illumination	
Number of cameras	Depends on length of section (number of gantries) and number of lanes
Number of camera sites	Depends on length of section
Camera resolution	N/A
Digital or analogue	Digital
Monochrome or colour	Monochrome
Camera activation	Laser triggered
Forward or rearward facing	Rearward-facing only
Camera per lane or multiple lanes	Designated cameras for each lane and hard shoulder. Cameras are cross referenced
Illumination approach	Near infrared
Infrastructure	
Camera mounting approach	All cameras mounted to overhead gantries
Purpose built or existing	Existing. Part of the motorway management system
Camera housing approach	Climate controlled housing, fully protected from weather conditions. Solid enough to withstand vandalism (not certified however). Cameras relatively out of reach
Power source	AC 220V
System Software & Processors	
Software characteristics	ANPR and object recognition for vehicle matching
Matching approach	Number plate cut out of picture and stored separately. This cut image processed by an ANPR algorithm
Location of processor	Roadside processors store data. ANPR processor located at back-office
System hardware	Standard, off the shelf PC (also capable of using a laptop)
Clock synchronisation	GPS receivers
Size and type of image data file	Fingerprints (image, date, time, location), 1kb each
Data storage approach	Fingerprints stored at roadside processor. If entry and exit fingerprints matched, combined fingerprint sent to back-office for further processing. Only data on offending vehicles communicated to back-office
Communications Network & Back Office	
Communication network approach	Ethernet
Information captured by system	Images at entry and exit points, date, time, location, vehicle classification, capture speed
Degree of back-office automation	Fully automated, manual checks only for those number plates that cannot be automatically read

5.2.16.4 Legislative characteristics

In the Netherlands, there are strict laws governing type approval and certification procedures concerning enforcement equipment. Each new system must be type approved and is required to undergo a certification procedure. In addition to the normal technical and troubleshooting management of the systems, the equipment must be re-calibrated and re-certified every two years. The National Police are responsible for the initial approval and certification of the system devices, while the Dutch Measuring Institute is responsible for evaluation of the systems.

To measure the shortest practicable distance between camera sites, a justified and certified measuring wheel attached to a vehicle is used. As stated earlier, signage on the approach to the enforced section is a legislative requirement in the Netherlands. According to the law, just one sign indicating the maximum speed limit and another indicating the end of that speed zone is sufficient. Nonetheless, stakeholders reported that at all locations speed limit signs are repeated frequently (e.g., every 100 meters) by means of a small traffic sign on each hectometre pole along the motorway and in the central verge as well as on electronic matrix signs. Signs are also used to warn motorists of the impending enforcement section prior to entering the enforcement corridor.

The onus of responsibility for speed infringements rests solely on the vehicle owner in the Netherlands. Moreover, for minor violations the registered owner is unable to acquit themselves even if they provide the details of the driver at the time the offence was committed[30].

5.2.16.5 Broader issues

Broader speed management issues: A number of additional speed enforcement methods are used in the Netherlands, including fixed instantaneous and mobile speed cameras and more manually operated approaches and traffic patrols. Stakeholders acknowledged that point-to-point speed enforcement cannot be applied in all locations, however noted that the approach is the predominant application for speed enforcement on motorways and on some stretches of secondary roads, as well as locations where traffic calming and the reduction of vehicle noise and emissions is critical. It was suggested that the technology is less amenable to complex sections of roads, urban road layouts and roadwork zones. The use of point-to-point is strongly viewed as complementary to more traditional speed enforcement practices, rather than a substitute.

The primary advantages associated with point-to-point speed enforcement were noted as improved traffic flow, reduced congestion, reduced crashes, improved compliance with speed limits and reduced vehicle noise and emissions.

Broader road safety and public health issues: Stakeholders reported that point-to-point shows potential as an effective approach to reducing the environmental impact of road traffic. They argued that the technology is a particularly effective method which can be applied before more source-orientated measures become available, such as lower-pollution vehicles, cleaner fuel alternatives and less road traffic.

Public education: Stakeholders reported the use of a variety of public education approaches in association with point-to-point speed enforcement systems, including the use of billboards,

[30] Only for crimes like drink driving or hit-and-run can the registered owner be acquitted by providing the details of the responsible driver.

media coverage on radio, television and in newspapers and thematic programs on television. It was argued that by maintaining a continuous process of communication during the development and implementation of the technology, the approach has been widely accepted among the motoring public. The billboards were highlighted as a specific approach that proved effective in promoting acceptance of the systems. Overall, it has been reported that many motorists perceive the technology to represent a fairer approach to speed enforcement compared to methods which measure instantaneous speeds only.

Evaluation: A number of evaluations of point-to-point systems in the Netherlands were reported by the stakeholders. Moreover, these were noted to have assessed various outcomes associated with the systems, including the impact on road safety (e.g., traffic crashes and vehicle speeds), as well as environmental benefits (e.g., vehicle noise and emissions), traffic flow and motorist acceptance. These studies are reviewed in Section 3.

5.2.17 Austria

5.2.17.1 Extent of use of point-to-point speed enforcement

Austria also employs point-to-point camera technology for the purposes of speed enforcement. There are currently three permanent installations and a single temporary installation in the country. The first implementation of the technology was on the A22 motorway in the Kaisermühlen tunnel near Vienna in August 2003. The monitored section is a 2.3 kilometre stretch of urban motorway with two separate tubes to the tunnel, three to four lanes in each direction, and entry and exit ramps within the tunnel. The tunnel has an average daily traffic flow of almost 92 000 vehicles (Stefan, 2006).

Permanent systems are also used on two sections of the A2 motorway. The first location is a 20 kilometre stretch at Mount Wechsel (between exits for Edlitz and Grimmenstein) and has been operational since February 2005. The second location is in the Ehrentalerberg tunnel, which spans four kilometres. There are limited opportunities for access and egress within either of the A2 installations. With regard to the A2 installation at Wechsel, the speed limit varies from 80 km/h to 130 km/h depending on the wetness of the road surface, with real-time speed limits communicated to drivers via VSL.

A mobile system is also used to enforce sections of road along a ten kilometre stretch of roadwork zones on the A12 motorway near Amras. At the time of the project, the mobile system was being used to enforce a one kilometre section of road. Table 5.19 outlines the locations and particular characteristics of point-to-point speed enforcement systems in Austria.

Table 5.19: Locations of point-to-point speed camera systems in Austria.

Road section	Date	Details
A22 Kaisermühlen tunnel	Sep 03	Permanent, 2.3 km length, 80 km/h for passenger vehicles & 60 km/h for heavy vehicles, tunnel, urban dual carriageway (7 lanes)
A2 Edlitz to Grimmenstein	Feb 05	Permanent
A2 Ehrentalerberg tunnel		Permanent
A12 Amras		Mobile/temporary, currently 1 km stretch enforced, roadworks zone

The Kaisermühlen tunnel installation was a direct response to a number of crashes occurring within the tunnel, which in turn triggered a number of regulations regarding how dangerous goods are transported through tunnels. The regulations stipulated that special guidance vehicles (e.g., pilot or escort vehicles) should be used, or other adequate measures were required to ensure adequate safety levels. Given the high traffic volume through the tunnel, guidance vehicles were deemed to be unfeasible. As a result, point-to-point cameras were installed as a compensating countermeasure. For the other permanent installations, crash history and speed-related problems were the main criteria, while improved safety in roadwork zones was the primary impetus behind the mobile system.

5.2.17.2 Technological characteristics

All systems involve designated cameras for each lane, with cameras cross-referenced to allow monitoring of vehicles changing lanes within the enforcement corridor. With respect to the A22 system, a laser scanner is used to differentiate between passenger vehicles and heavy vehicles given that different speed limits apply to each vehicle type in the tunnel (80 km/h and 60 km/h, respectively). The cameras are attached to purpose-built overhead gantries and none of the systems involve contiguous enforcement corridors. GPS technology is used to synchronise the time clocks within the system, with monitoring software used to automatically deactivate the system if correct synchronisation is not achieved. Stakeholders reported that no attempts to vandalise the equipment have been encountered.

Table 5.20 provides a comprehensive overview of the technological characteristics of point-to-point speed enforcement systems in Austria.

5.2.17.3 Operational characteristics

The systems are operated by the Austrian motorway provider (ASFINAG), which is an executive authority under the Austrian Ministry of Transport, Innovation and Technology. The jurisdictional government is responsible for all handling of captured images and data collected by the system. Police process data at regional data centres and the relevant district authorities are responsible for the administration of infringement notices to vehicle owners (or drivers if the owner nominates another driver).

Calibration checks are performed bi-annually, with basic camera maintenance, such as cleaning performed when necessary (e.g., when the quality of the images becomes inadequate).

While stakeholders noted that the system may incorrectly identify the number plate sequence, they noted that of more importance is consistency at the entry and exit points, such that if the system can still match the number plate then the vehicle will be captured and during the manual verification the correct number plate can be identified. The data collected from the systems are not linked to other databases, with the exception of the licence register for the purposes of identifying the owner of the vehicle.

Both an enforcement tolerance and device tolerance are used in association with the systems; however such thresholds are not publicly communicated. In addition, enforcement tolerances operated in association with point-to-point technology do not differ compared to other speed enforcement approaches.

Table 5.20: Technological overview of point-to-point speed enforcement systems in Austria.

System Component	Specific Characteristics
Cameras & Illumination	
Number of cameras	Depends on number of lanes. Two cameras are used per lane, one at the entry point and one at the exit point
Number of camera sites	2 camera sites (entry/exit) – no systems involve contiguous enforcement corridors
Camera resolution	PAL-video resolution
Digital or analogue	Analogue
Monochrome or colour	Monochrome
Camera activation	Laser triggering (in the Kaisermühlen tunnel this process also used to detect vehicle type)
Forward or rearward facing	Rearward facing only
Camera per lane or multiple lanes	Designated camera for each lane. Cameras are cross referenced
Illumination approach	Continuous infrared
Infrastructure	
Camera mounting approach	Overhead gantries (both permanent and temporary systems)
Purpose built or existing	Purpose built
Camera housing approach	Standard housing, weatherproof – not vandalism proof given gantry mounting and restricted access
Power source	DC (220V)
System Software & Processors	
Software characteristics	ANPR
Matching approach	Template matching
Location of processor	ANPR engine located at roadside
System hardware	Industrial PC
Clock synchronisation	GPS
Size and type of image data file	Approximately 1MB, TIFF image
Data storage approach	Data block involves two images (entry and exit) and a text file
Communications Network & Back Office	
Communication network approach	Ethernet, end-to-end encryption from roadside equipment to back-office
Information captured by system	Vehicle type, lane position, location, timestamp, speed limit, calculated speed, images at entry and exit points
Degree of back-office automation	Manual verification of all infringements

5.2.17.4 Legislative characteristics

In the early years of implementation of point-to-point in Austria, difficulties were experienced in regard to prosecuting some offenders detected by the systems due to legislative loopholes for foreign drivers. Specifically, drivers from some foreign countries could only be prosecuted if photos identified the driver (due to the law in their respective countries). Given that it has been estimated that as many as 60% of all speed offenders in Austria are foreign drivers (Townsend, 2006), this represents a particular concern for stakeholders. Consequently, the European Union Council created legislation that ensured mutual recognition across borders of financial penalties which took full effect in 2007 (Townsend, 2006). Thus, driver identification is no longer a requirement in Austria.

Prior to the enforcement of average speeds in Austria, average speed control was added to the Highway Code as a new method of speed enforcement. In addition, the Code prohibits the use of other speed enforcement methods within sections controlled by point-to-point cameras. Traffic regulations were also amended to allow for the storage of images for measurement and enforcement purposes.

Before the systems are installed, they must pass an Austrian type homologation procedure, with the technology appropriately calibrated and each location approved by the Austrian Federal Office for Metrology and Surveying. During the calibration and approval process the distance between the camera sites are metered. According to a decision by the Austrian Constitutional Court, point-to-point speed enforcement in the country is in line with data protection laws.

For smaller infringements, vehicle owners are provided with the option to pay an anonymous fee, while vehicle owners are required to disclose to authorities the identification of the offending driver in relation to more severe infringements.

Regarding signage, a specific sign has been designed to communicate to drivers the presence on point-to-point enforcement. The sign involves a camera pictogram and the text ‘Section Control’ (black on white background). It is a legislative requirement that the sign be used prior to the enforced area (typically located 100 metres prior to the entry point of the system), as well as another sign used to identify the end of the enforcement corridor. This latter sign reads ‘End of Section Control’ and includes a pictogram of a crossed camera.

While variable speed limits exist for some of the enforced sections, it is a legislative requirement that a consistent speed limit must exist throughout the enforced section. That is, while the speed limit of an enforced section may vary depending on vehicle type or weather conditions, none of the systems involve more than one speed limit zone within the enforcement corridor.

Stakeholders highlighted that privacy concerns have been an important issue throughout the entire design and implementation process of point-to-point speed enforcement, with the Austrian Data Security Office involved in the project from its inception. It was noted that no individual or organisation has access to data relating to vehicles which pass through the enforced section that have not committed a speeding offence. Such data is deemed to be technically unfeasible and is destroyed immediately after the vehicle has exited the section.

Every deployment of point-to-point speed cameras must be able to establish an adequate justification regarding why that section of road is at-risk, as well as explaining why other approaches are not more appropriate. For example, roads with speed limits of 130 km/h are not eligible for the use of point-to-point until other countermeasures, such as reducing the speed limit, have been trialled.

5.2.17.5 Broader issues

Broader speed management issues: A number of additional approaches for speed enforcement are used in Austria, including fixed instantaneous speed cameras, mobile speed cameras and hand-held or moving-mode radars. Stakeholders reported that point-to-point speed cameras are a well accepted speed enforcement tool in the country, aimed at increasing safety in tunnels and in motorway roadwork zones. It was reported that the use of the technology is likely to increase in the coming years; however is unlikely to replace other speed enforcement methods, and rather is seen as a complementary approach. At the time the research consultation was conducted it was noted that point-to-point speed cameras enforce only a small proportion of the 2 100 kilometres of highway in Austria.

Stakeholders reported a number of advantages associated with the use of point-to-point, including exceptional rates of compliance with speed limits (<1% of offending vehicles), improved traffic flow (as a result of reduced speed variation between vehicles), reduced congestion, fewer lane changes (and thus fewer potential conflict situations), reduced traffic crashes and casualties, reduced vehicle noise and emissions and a positive benefit-cost-ratio. Reported disadvantages of the technology included substantial set-up and maintenance costs and initial public discussion regarding the issue of data security.

Public education: There was extensive media coverage regarding the installation of the systems, however stakeholders suggested that such campaigns were aimed at increasing awareness, rather than educating motorists. It was acknowledged that the dissemination of information is critical, particularly in relation to data security issues, the hypothecation of revenue from infringements and the positive benefits of the use of point-to-point speed enforcement in other countries.

Evaluation: A major evaluation of the A22 system has been conducted by the KfV as part of the EU project ROSEBUD. This study, which included a cost-benefit study, and other data relating to evaluations of Austrian systems are reviewed in Section 3.

5.2.18 Italy

5.2.18.1 Extent of use of point-to-point speed enforcement

At the time of the stakeholder consultation, two point-to-point systems were operational in Italy. The first is a proprietary system, referred to as Tutor, and was developed by ASPI (Autostrade per l'Italia SpA), a motorways agency. This system is operated on the ASPI motorway network and represents the most extensive system employed in Italy, covering approximately 2 900 kilometres of the motorway network. This system was first introduced in December 2005 and has experienced considerable growth in its use since that time. The second system is referred to as Celeritas and is developed by Engine SRL. This system is less extensively operated across the country, typically on rural roads. While the National Police are responsible for the administration of infringement notices in relation to the Tutor systems, Celeritas enforcement is conducted by the police corps of the local municipalities.

Unfortunately, stakeholder consultations did not allow the research team to collect sufficient information regarding the Celeritas systems. Thus, the following sections refer specifically to the Tutor systems operated throughout Italy, unless otherwise noted.

The ASPI motorway network includes over 3 400 kilometres of road and toll highways. A total of 320 point-to-point speed camera sites exist across that network, covering more than 2 900 kilometres. Systems operate in 'site couples', such that every site can act as both an entry and exit point for a system. Approximately 200 independent sections of road are monitored. The average length of enforced Tutor sections is approximately 15 kilometres, with a range from two to 40 kilometres. Camera sites are typically installed before each road exit or junction, to remove, or at least minimise, the opportunities for access and egress within the enforcement corridor. Thus, almost all Tutor systems involve contiguous enforcement corridors.

All systems (including Celeritas) are permanent and each independent section involves only a single speed limit throughout the enforcement corridor, however different classifications of vehicle can travel at different speeds (the Tutor system automatically identifies vehicle class and the corresponding speed limit). Locations in which all point-to-point speed enforcement systems operate are chosen based on crash history, speeding problems and traffic flow issues. In addition, the process of identifying appropriate locations involves filtering those where crashes can be readily attributed to road design issues or non-speed-related causes. Finally, the expected efficiency of the system is calculated by predicting the proportion of vehicles that may exit the system through off-ramps within the section, or stop at service and/or parking areas within the section.

Table 5.21 outlines the location and characteristics of Tutor systems throughout Italy.

Table 5.21: Locations of Tutor systems in Italy.

Road section	Start (km mark)	End (km mark)	Direction	Length (km)
A1 Milano to Napoli	San Zenone al Lambro (12.3)	Bivio A1/A14 (186.9)	Napoli	174.6
A1 Milano to Napoli	Bivio A1/A14 (186.9)	San Zenone al Lambro (12.1)	Milano	174.8
A1 Milano to Napoli	Orte (489.9)	Caserta Nord (732.8)	Napoli	242.9
A1 Milano to Napoli	Caserta Nord (736.7)	Orte (493.9)	Milano	242.8
A4 Milano to Brescia	Cavenago (149.3)	Brescia Ovest (214.4)	Brescia	65.1
A4 Milano to Brescia	Brescia Ovest (217.0)	Agrate (146.9)	Milano	70.1
A4 Brescia to Verona	Brescia est (225.9)	Somma Campagna (268.8)	Verona	42.9
A4 Brescia to Verona	Somma Campagna (273.5)	Peschiera (260.4)	Brescia	13.1
A4 Brescia to Verona	Desenzano (246.3)	Brescia Est (232.0)	Brescia	14.3
A4 Venezia to Trieste	S. Dona di Piave (24.5)	Bivio A4/A23 (92.0)	Trieste	67.5
A4 Venezia to Trieste	Latisana (72.3)	Venezia est (20.8)	Venezia	51.5
A4 Venezia to Trieste	Villesse (101.7)	Redipuglia (108.7)	Trieste	7.0
A4 Venezia to Trieste	Villesse (108.7)	Palmanova (97.8)	Venezia	10.9
A7 Genova to Serravale	Isola del Cantone (99.2)	Genova Bolzaneto (125.1)	Genova	25.9
A7 Genova to Serravale	Genova Bolzaneto (124.8)	Isola del Cantone (104.8)	Serravale	20.0
A8 Milano to Varese	Legnano (13.5)	Gallarate (27.2)	Verase	13.7
A8 Milano to Varese	Gallarate (29.0)	Origgio ovest (12.2)	Milano	16.8
A13 Bologna to Padova	Padova Industriale (114.2)	Arcoveggio (1.4)	Bologna	112.8
A13 Bologna to Padova	Arcoveggio (1.5)	Padova Industriale (111.3)	Padova	109.8
A14 Bologna to Taranto	Raccordo Casalecchio (9.1)	Rimini Nord (115.8)	Taranto	106.7
A14 Bologna to Taranto	Rimini Nord (118.4)	Raccordo Casalecchio (9.6)	Bologna	108.8
A14 Bologna to Taranto	Giulianova (327.0)	Bivio A14/A25 (374.9)	Taranto	47.9
A14 Bologna to Taranto	Bivio A14/A25 (370.9)	Val Vibrata (329.5)	Bologna	41.4
A14 Bologna to Taranto	Pescara ovest (378.4)	Bivio A14/A16 (600.0)	Taranto	221.6
A14 Bologna to Taranto	Cerignola est (590.8)	Bivio A14/A25 (378.4)	Bologna	212.4
A14 Bologna to Taranto	Canosa (609.0)	Bari nord (668.2)	Taranto	59.2
A14 Bologna to Taranto	Bari sud (682.0)	Bivio A14/A25 (605.5)	Bologna	76.5

Road section	Start (km mark)	End (km mark)	Direction	Length (km)
A23 Palmanova to Tarivisio	Gemona (43.0)	Pontebba (89.6)	Tarivisio	46.6
A23 Palmanova to Tarivisio	Pontebba (97.0)	Udine nord (31.0)	Palmanova	66.0
A23 Palmanova to Tarivisio	Udine sud (16.6)	Bivio A23/A4 (3.2)	Palmanova	13.4
A24 Roma to Teramo	Tivoli (14.5)	Carsoli (49.2)	Teramo	34.7
A24 Roma to Teramo	Carsoli (51.5)	Tivoli (14.5)	Roma	37.0
A24 Roma to Teramo	Valle de Salto (74.6)	L'Aquila Ovest (100.1)	Teramo	25.5
A24 Roma to Teramo	L'Aquila Est (108.0)	Valle de Salto (75.9)	Roma	32.1
A25 Torano to Pescara	Avezzano (87.1)	Sulmona (135.9)	Pescara	48.8
A25 Torano to Pescara	Sulmona (137.9)	Avezzano (89.1)	Torano	48.8
A26 Genova Voltir to Gravellona T.	Bivio A26/A10 (3.2)	Bivio A26/Predosa-Bettole (44.5)	Gravellona	41.3
A26 Genova Voltir to Gravellona T.	Bivio A26/Predosa-Bettole (43.0)	Bivio A26/A10 (1.7)	Genova	41.3
A28 Portogruaro to Pordenone Conegliano	Azzano-Decimo (15.2)	Villotta (6.6)	Portogruaro	8.6
A30 Caserta to Salerno	Nola (17.2)	Casel San Giorgio (42.8)	Salerno	25.6
A30 Caserta to Salerno	Nocera Pagani (41.0)	Bivio A30/A1 (1.3)	Caserta	39.7
A3 Napoli to Salerno	Scafati (25.0)	Angri (29.8)	Salerno	4.8
A3 Napoli to Salerno	Angri (29.8)	Scafati (25.0)	Napoli	4.8
A3 Napoli to Salerno	Cava Dei Tirreni (42.8)	Salerno (51.7)	Salerno	8.9
A3 Napoli to Salerno	Salerno (51.7)	Cava Dei Tirreni (42.8)	Napoli	8.9
A6 Torino to Savona	Millesimo (91.1)	Ceva (85.0)	Torino	6.1
A6 Torino to Savona	Altare (118.5)	Bivio A6/A10 (122.6)	Savona	4.1
A6 Torino to Savona	Marene (33.4)	Carmagnola (14.4)	Torino	19.0
A6 Torino to Savona	Carmagnola (14.4)	Marene (33.4)	Savona	19.0
A1 Diramazione Roma sud	San Cesaro (3.8)	Monteporzio Catone (10.0)	G.R.A	6.2
A1 Diramazione Roma sud	Monteporzio Catone (11.0)	San Cesaro (3.9)	A1	7.1
A56 Tangenziale di Napoli	Astroni (4.3)	Fuorigrotta (9.7)	Est	5.4
A56 Tangenziale di Napoli	Arenella (15.4)	Capodimonte (17.4)	Est	2.0
A56 Tangenziale di Napoli	Camaldoli (13.2)	Vomero (11.4)	Ovest	1.8
A56 Tangenziale di Napoli	Fuorigrotta (9.9)	Agnano (8.1)	Ovest	1.8

Source: ASPI website: http://www.autostrade.it/en/.

5.2.18.2 Technological characteristics

The Tutor systems operate with a designated camera for every monitored lane, including the emergency lanes, at both the entry and exits points. As noted earlier, approximately 320 point-to-point speed camera sites exist across the ASPI network, covering approximately 200 enforcement sections. Multiple cameras are associated with each enforcement section, with the exact number depending on the number of lanes and number of camera sites in the section. Thus, there are literally thousands of average speed cameras being operated.

Stakeholders reported that the decision for overhead mounting was a function of avoiding situations where vehicles obscure other vehicles. A number of systems involve contiguous enforcement corridors, with the precise number of sites in a system dependent on the number of junctions within the enforced section. The cameras are typically mounted on purpose-built overhead gantries. Due to privacy legislation in the country, only rearward facing cameras are used, given that face obscuration is not considered sufficient for the protection of personal information.

The time clocks within the systems are synchronised using GPS and NTP to a centralised system. Stakeholders noted that if the NTP synchronisation is lost, the cameras immediately go offline until the signal is fully recovered. It was reported that this is a relatively rare occurrence.

Only data for offending vehicles is sent to back-office, with all data on non-offending vehicles immediately erased. Transmitted data are encrypted to avoid unauthorised access to the information and then digitally signed with a unique signature certificate by every PC to avoid unauthorised manipulation. In addition, all communication is conducted though secure protocols.

Manual checks are performed on all images of offending vehicles at the back-office. These checks assess the accuracy of the number plate recognition process, as well as the class of the vehicle. Once verified, an automatic process identifies the address of the offending vehicle and produces an infringement notice. The only manual step in this process involves a signature from a police officer, which is a legislative requirement. For privacy reasons, images of the offending vehicle are not included on the infringement notice, unless explicitly requested by the offender.

The stakeholders reported that in more than six years of operation, no equipment had been intentionally vandalised. They reported that access to the overhead gantries from the ground level is restricted and that the roadside cabinet (containing the local PC) has a reinforced enclosure with an alarm system that automatically disables the PC and the cameras it if the door is opened in an unauthorised fashion.

Table 5.22 provides a comprehensive overview of the technological characteristics of point-to-point speed enforcement systems in Italy.

5.2.18.3 Operational characteristics

As stated, the Tutor system is operated by ASPI, who are also responsible for all technical aspects and the infrastructure. In addition, the National Police are responsible for the issuing of infringement notices in association with the point-to-point systems and provide the personnel for the verification of offences. Conversely, the Celeritas system is operated by Engine SRL, with the infringement processes conducted by police corps in municipal areas. It is forbidden by law to outsource the operation of the systems to a private company; only jurisdictional government is allowed.

Stakeholders reported that considerable police resources and time are devoted to point-to-point speed enforcement. Specifically, in relation to the Tutor system, approximately 70 full-time police officers are employed to manage the infringement process. Enforcement coordination is performed by Home Land Security.

A number of mandatory maintenance schedules are associated with both the Tutor and Celeteris systems. The systems must undergo an annual validation tests, every local PC must undergo a clock time alignment test towards a certified clock and the surveyed distance must be verified by an odometer.

The Tutor system is capable of reading plates from various European countries, particularly neighbouring countries and of course Italian plates, which constitute approximately 90% or more of the traffic on Italian motorways. The stakeholders reported no difficulties associated with the recognition and reading of plates from other countries. The system is designed to automatically identify the nationality of the plate in order to send the infringement notice to the right nation.

Legislation in Italy prohibits the use of information collected by the Tutor system for linking to criminal databases or any other database. The only exception is the license registration databases for identification of the vehicle class (before the police manually verify this information) and for owner identification. Nonetheless, stakeholders reported that the systems are fully capable of being linked to any number of databases to trigger particular concerns when number plates are detected.

5.2.18.4 Legislative characteristics

In Italy, a homologation process must be conducted prior to the installation of a point-to-point enforcement system. This process involves a series of field, laboratory and circuit tests aimed to validate the performance of the system in relation to numerous factors. These include: the accuracy of vehicle detection under real traffic conditions and at various speeds (capture at speeds of at least 260 km/h are tested in circuit); the accuracy of the speed measurement; the accuracy of vehicle classification identification under real traffic conditions; the accuracy of number plate recognition and reading under various light and weather conditions; the accuracy of number plate matching from the entry to exit points of the system; and, impact on vehicle emissions. In addition, after this process, the full system is operated for a designated period in ‘test mode’, in cooperation with the police to certify that the system operates sufficiently.

The shortest practicable distance between cameras is measured using a certified automotive distance measurer that was designed by Autostrade per Italia. This measurement is conducted by the motorways agency prior to the installation of and system.

In Italy, owner responsibility is associated with camera-detected offences. That is, it is the responsibility of the vehicle owner to declare the name of the driver if they claim not to have been in operation of the vehicle at the time of the offence. If another driver is not declared, the owner is administered with the subsequent penalties associated with the offence. As stated previously, direct identification of drivers (and/or passengers) by an automatic enforcement system is forbidden by law in the country, and face obscuration is not considered a sufficient approach to protecting personal information.

Italian legislation specifies that both instantaneous and average speed enforcement devices operate with a tolerance of 5% of the capture speed, or at least 5 km/h (whichever is greater). The issuing of multiple infringements for the same stretch of road is forbidden by law in the country. Thus, where multiple infringements are detected on successive segments on a single enforced section of road, only one offence is pursued. As stated previously, while the Tutor system is capable of also measuring instantaneous speeds, this function is not employed. The stakeholders reported that this decision is based on minimising the extent of sudden braking associated with identifying an instantaneous speed camera.

Signage of the Tutor system is a legislative requirement, and must include one sign within the enforcement corridor and a warning sign at least one kilometre before the entry camera.

Personal data mining (e.g., number plate information, acquired images, etc) must be in accordance with the data protection act and Italian privacy laws. No privacy issues associated with the Tutor system were noted by the stakeholders. Indeed, it was highlighted that data collected by the system on non-offending vehicles is deleted as soon as possible after the vehicle has passed the exit point of the system.

Table 5.22: Technological overview of point-to-point speed enforcement systems in Italy.

System Component	Specific Characteristics
Cameras & Illumination	
Number of cameras	Depends on number of lanes. Two cameras are used per lane, one at the entry point and one at the exit point (including emergency lanes)
Number of camera sites	Depends on the number of exits/junctions within the enforcement corridor
Camera resolution	1600x1200 pixel, 25 or 68 fps
Digital or analogue	Digital
Monochrome or colour	Monochrome (near infrared)
Camera activation	Most systems by induction loops – new systems being developed use radar (currently seeking approval from the Ministry of Transport)
Forward or rearward facing	Rearward facing
Camera per lane or multiple lanes	Designated camera per lane
Illumination approach	Infrared, synchronised with the camera's shutter
Infrastructure	
Camera mounting approach	Overhead gantry mounted most common approach
Purpose built or existing	Typically purpose-built
Camera housing approach	Metallic case providing IP66 protection
Power source	AC. Local PC enclosure includes an AC/DC transformation, energy regulators and filters, and backup batteries
System Software & Processors	
Software characteristics	ANPR and OCR, multiple softwares run on each image until one succeeds, local PC performs other attempts if the first one fails however majority of cases the first software succeeds (workload for the local PC is low)
Matching approach	Multi-stage algorithm developed in the software – uses template matching, structural analysis and neural networks
Location of processor	At the camera
System hardware	Industrial PC for the local PC, a centralized server that performs all remaining operations
Clock synchronisation	GPS and NTP synchronisation with a centralised system
Size and type of image data file	JPEG, 50KB
Data storage approach	Stored in both the local PC and in the central system (which collects only the vehicle plate, category and speed class, in order to perform transit matching between two adjacent sites)
Communications Network & Back Office	
Communication network approach	Typically fibre-optic cables (Ethernet if fibre-optic not available), only data for offending vehicles sent to back-office, data are encrypted and digitally signed with unique signature certificate by every PC (avoids uncontrolled manipulation) and all the communication takes place though secure protocols
Information captured by system	Vehicle instantaneous speed, vehicle plate, vehicle category, time and date, lane position, serial number of the camera, capture speed, images at entry and exit points
Degree of back-office automation	Manual checks of all entry and exit images to clarify number plate, vehicle type

This process is typically immediate, however can take up to three hours. Data that cannot be processed by the ANPR and OCR software are deleted within 72 hours, including manual attempts to identify the number plate. Data encryption and security protocols further protect the data. As stated earlier, the importance of data security was strictly analysed by the Ministry of Transport during the homologation process.

5.2.18.5 Broader issues

Broader speed management issues: In Italy, a range of other automated enforcement methods are used to monitor vehicle speeds, including the use of both fixed instantaneous and mobile speed cameras, as well as routine traffic patrols and hand-held laser operation. Stakeholders suggested that point-to-point speed enforcement is a predominant task undertaken by police, with only routine patrolling tasks demanding more police time[31]. The Tutor system was described as ‘stable and mature’, and that it was unlikely to change significantly in the coming years. However, the continued growth of the system is likely.

The stakeholders identified several advantages associated with the use of point-to-point speed enforcement. These included substantial reductions in average speeds and the speed variation between vehicles, reduced traffic crashes and casualties, and perceptions among road users that the technology represents a fairer approach to speed enforcement. Few disadvantages were reported. It was noted that point-to-point speed enforcement is not an approach that will generate significant amounts of revenue from infringements, with offence rates argued to be significantly lower compared to instantaneous speed enforcement approaches.

Public education: A range of public education approaches have been adopted to inform motorists of various Tutor installations, however not all systems are associated with public education campaigns. Approaches employed in association with publicised systems include newspaper advertisements, television interviews with the police officers regarding the operation of the Tutor system, information panels in the service areas throughout the motorway network, as well as detailed information on the websites of involved stakeholders explaining the functionality and technology of the systems, the extent to which they are installed (including a map of all locations) and an emphasis on the road safety benefits associated with the approach.

A transparent approach to public communication is argued to increase the perceived legitimacy of the systems and improve driver acceptance. Stakeholders reported that there is evidence to suggest that those systems installed without associated public education typically have poorer rates of driver acceptance, as measured by driver surveys. It was also reported that other approaches to speed enforcement (e.g., fixed instantaneous and mobile speed cameras) are typically associated with more negative driver attitudes.

Evaluation: A number of non-independent studies have analysed the impact of the Tutor system on key road safety outcomes. In addition, a number of independent studies have assessed the impact of the systems on vehicle emissions, traffic flow dynamics and level of driver compliance. These studies are reviewed in Section 3.

[31] This refers to the number of man-hours spent conducting various tasks, rather than to the allocation of police resources.

5.2.19 Switzerland

5.2.19.1 Extent of use of point-to-point speed enforcement

There are currently three point-to-point speed enforcement systems operating in Switzerland, two of which are permanent systems and one a mobile system. Only one of the permanent systems is fully operational, with the mobile system and other permanent system both currently being trialled to gain approval. The use of these systems in the country is still in its infancy. Indeed, the fully operational system, located on a 1.8 kilometre stretch of the Arisdorf tunnel on the A2 motorway heading from Basel to Lucerne, only became enforceable in January 2011. The trial permanent system is located on an 8.5 kilometre stretch of the A9 motorway between Junction Aigle and Bex Nord, and was still under construction at the time of writing this report. Finally, the mobile system, which is yet to gain appropriate approval for operation, is pending trial. Official approval is expected in 2011 for testing in highway construction sites and as a comparison with conventional radar systems.

At the permanent trial site, there is an opportunity for motorists to enter or exit the section without being registered by the system and the initial entry point. As a result, the stakeholders reported plans to test combining the mobile system with the permanent system, such that the mobile system will be installed at the junction location to ensure all motorists are monitored.

The primary criterion used to choose locations for the use of point-to-point speed enforcement in Switzerland is road safety, particularly crash history and speed-related problems. In addition, traffic flow issues are also considered but are not the impetus of implementation. Table 5.23 outlines the location and characteristics of point-to-point speed camera systems in Switzerland.

Table 5.23: Locations of point-to-point speed camera systems in Switzerland.

Road section	Date	Details
A2 motorway, Arisdorf tunnel heading from Basel to Lucerne	Jan 11	Permanent, 1.8 km length, 80/100 km/h VSL, tunnel
A9 motorway between Junction Aigle and Bex Nord	Pending	Permanent, pending trial, 8.5 km stretch
Mobile system	Pending	Mobile system, pending trial for use in construction zones and across motorway

5.2.19.2 Technological characteristics

As stated, only one point-to-point speed enforcement system is currently fully operational in Switzerland. This system involves designated number-plate recognition cameras for each lane, as well as evidence cameras at the exit point, and finally a series of six video cameras which continually record the VSL signs within the enforcement areas. The evidence and speed limit cameras are necessary to meet the legislative requirements outlined in Section 5.3.6.4 below. While the number plate recognition cameras capture rearward images of the vehicle only, evidence cameras capture both the front and rear of the vehicle to aid in the process of driver identification. The number plate recognition cameras are overhead mounted on purpose built gantries, while the evidence cameras are pole mounted in the middle of the motorway between the directions of traffic. The mobile systems involve three main components, referred to as 'bodies'.

A modified version of ANPR software is used by the system, such that the 'credibility-grade' of the matching is reduced. This essentially means that while the system may more readily confuse an 8 for a B, the important function is that the same recognition error is made at both the entry and exit points. The level of automation of back-office proceedings differs depending on the Police cantonal in question. All involve a high degree of automatic checks but the number plate and vehicle class are typically checked manually.

The stakeholders did not report any attempts to vandalise the point-to-point system, however noted that vandalism was a relatively common issue associated with other automated speed enforcement methods. It was reported that all systems on the motorway have online connection with the corresponding Police cantonal, thus aiding the identification of individuals who attempt to damage the system. Table 5.24 provides a comprehensive overview of the technological characteristics of point-to-point speed enforcement systems used in Switzerland.

5.2.19.3 Operational characteristics

The Swiss Federal Roads Office (FEDRO) is responsible for the motorways (e.g., federal roads) in Switzerland. In addition, there are 26 cantons[32] within the country, each with their own cantonal Police organisation[33]. The cantonal Police are responsible for the enforcement on the motorways including the point-to-point systems. All revenue generated from the systems is channelled back into the cantons. Therefore, stakeholders reported that the cost-effectiveness of the systems is typically perceived to represent the increase in road safety for the expenditure of resources on the systems.

The systems are preceded by two signs warning motorists that average speed measurements will be conducted for the next ‘XX kms’. There is a legislated enforcement tolerance of 5 km/h on roads with speed limits up to 100 km/h and 6-7 km/h on roads with greater speed limits. Stakeholders highlighted the accuracy of the system however, stating that a tolerance of 1 km/h would be sufficient from the technical point of view.

Two independent PC clocks are operated in parallel to synchronise the systems and checked against one another regularly. In addition, a Meinberg time server (via GPS) also synchronizes the two PC clocks once a day.

[32] Cantons refer to jurisdictions within the country, and are similar to states, districts, or counties.
[33] There is no federal police organisation in Switzerland.

Table 5.24: Technological overview of point-to-point speed enforcement systems in Switzerland.

System Component	Specific Characteristics
Cameras & Illumination	
Number of cameras	One camera for each lane at entry and exit, plus six cameras which film the speed limit signs (A2 system only), plus front and back evidence-camera at the exit
Number of camera sites	2 camera sites (entry/exit) – no contiguous enforcement corridors
Camera resolution	1.4 megapixels for the number plate recognition cameras and 12 megapixels for the evidence-cameras. Speed limit sign cameras are video-cameras with full HD resolution
Digital or analogue	Digital
Monochrome or colour	Monochrome 32 bit
Camera activation	Two laser-scanners which create a 3D picture for classification, triggered when the vehicle leaves the second scanner. For the evidence-camera, the time taken for the cameras to trigger is calculated using the instantaneous speed of the vehicle at the exit, the lane and the distance to the camera
Forward or rearward facing	Number-plate cameras are rearward only, evidence-cameras are both
Camera per lane or multiple lanes	Designated number-plate camera for each lane, evidence cameras capture both lanes
Illumination approach	Infrared flash for number-plate cameras and visible flash for evidence cameras
Infrastructure	
Camera mounting approach	Number-plate cameras: overhead gantries, evidence cameras: pole-mounted (situated on the middle of the motorway between directions), mobile system: consists of three parts
Purpose built or existing	Purpose built (however it is planned that further systems will use existing gantries)
Camera housing approach	Each housing has a heater, a fan, is water-proof and is protected against vandalism
Power source	AC 230V 16A (mobile system also includes battery packs in the housing)
System Software & Processors	
Software characteristics	Modified ANPR software (modification involved reducing the 'credibility-grade'); matching software to compare entry and exit data, calculate average speed and trigger the evidence-cameras; speed-sign recognition software; encryption software; automatic picture enhancement software
Matching approach	N/A
Location of processor	Roadside
System hardware	Industrial PC with Linux operating system
Clock synchronisation	
Size and type of image data file	JPEG (maximum 90% compression) and XML-files which are encrypted and combined in a ZIP-file which is again encrypted
Data storage approach	All files are encrypted and stored at roadside processor prior to communication transfer
Communications Network & Back Office	
Communication network approach	Either fibre optic or 3G. The system typically communicates through a closed network of the FEDRO but can also use conventional and mobile networks. Files are transferred through a VPN-channel to a FTP-server of the police. Also possible to collect data by USB-stick. There are several firewalls and closed network-circuits
Information captured by system	Vehicle type, lane position, encrypted license-plate, speed limit, vehicle classification, entry lane, exit lane, time and date, images at entry and exit points, system ID and components data
Degree of back-office automation	Various approaches, all involve a high degree of automatic checks but manual checks are important to some cantonal police forces, the number plate and vehicle class are typically checked manually

5.2.19.4 Legislative characteristic

Type approval is required prior to the installation of point-to-point speed enforcement systems in Switzerland, with requirements for approval set by the National Metrology Institute (METAS). This organisation is also responsible for the annual certification and re-certification of the systems.

The distance between entry and exit can be measured in two ways. Firstly, the distance is officially measured by the METAS, using an optical distance measurement system installed on a vehicle which measures the distance five times with an allowable maximum difference of 3cm. Secondly, a GPS satellite approach is also used.

In Switzerland, driver identification is required for the police and courts to charge an individual with a speeding offence, and thus photographic evidence of the driver is a necessity. Moreover, it is a requirement that such evidence is captured within 0.4 seconds after the motorist has left the enforced section (e.g., after reaching the exit point of the system).

The speed limit within the enforced section must be consistent across the entire length, however may change over time (e.g., variable speed limits). Indeed, VSL is used to communicate real-time speed limits to motorists in association with the A2 system, which changes from 80 km/h to 100 km/h. To provide evidence that VSL signs were displaying the correct speed limit information to motorists, it is a requirement to include images of every speed limit sign within the enforced section at the approximate time of the offence to the datablock of the offence. Stakeholders reported that this requirement limited their ability to develop systems with contiguous enforcement corridors, given that the maximum possible distance of an enforced section is restricted by junctions and different speed limits.

5.2.19.5 Broader issues

A number of perceived advantages associated with point-to-point speed enforcement were reported by stakeholders. These included more homogenous traffic flows and less congestion and greater headway between vehicles.

5.2.20 Belgium

5.2.20.1 Extent of use of point-to-point speed enforcement

In Belgium, there is one permanent point-to-point system being trialled on a 1.9 kilometre stretch of the E17 motorway from Antwerp to Kortrijk on the viaduct in Gentburgge near Ghent. The system monitors traffic travelling in one direction only (towards Kortrijk) across four lanes (three standard lanes and an emergency lane). There are no opportunities for access and egress throughout the enforcement corridor. While only one speed limit exists within the section, the system has the capability to communicate with VSL, and would require only an additional software installation.

The trial site was chosen for a number of reasons. Prior to the installation of the point-to-point system, eight fixed instantaneous speed cameras were used along the enforced stretch. The section of road has a lower speed limit than the remainder of the motorway, which was introduced due to issues associated with excessive vehicle noise in the area[34]. As a result of the existing cameras at the location, a number of the technological

[34] A noise-reducing barrier was also trialled at the location but was found to have very limited effectiveness.

components required for the implementation of the point-to-point system were already present along the stretch, lowering the costs associated with the system.

Stakeholders suggested that roads with regular congestion do not represent efficacious use of the technology. In addition, it was suggested that reinforced roads (e.g., with iron in them) should be avoided given that the iron reduces the likelihood that the induction loops will detect vehicles.

Table 5.25 outlines the location and characteristics of point-to-point speed camera systems in Belgium.

Table 5.25: Location of the trial point-to-point speed camera system in Belgium.

Road section	Details
E17 motorway from Antwerp to Kortrijk on the viaduct in Gentburgge near Ghent	Trial site, permanent installation, 1.9 km length, single direction monitored (3 lanes + emergency lane)

5.2.20.2 Technological characteristics

The E17 trial system in Belgium involves a simple entry/exit point design, with no contiguous enforcement corridors. A total of 10 rearward facing cameras are used by the system, with a designated camera for each of the three monitored lanes and the emergency lane. The cameras are overhead mounted to gantries, with one purpose-built for the system and the other an existing gantry used for VMS. The back-office, where the ANPR processor is located, is semi-automatic, with every image pertaining to offending vehicles required to be checked manually. The stakeholders did not report any issues associated with vandalism at the time of the project.

Table 5.26 provides a comprehensive overview of the technological characteristics of the trial system.

5.2.20.3 Operational characteristics

Limited information was available regarding the operational characteristics of the trial system. However, stakeholders reported that the system can be linked to enforcement databases, such that it can identify if the offending vehicle or number plates are associated with any outstanding crimes.

5.2.20.4 Legislative characteristics

Limited information was also available regarding the legislative characteristics associated with point-to-point speed enforcement in Belgium; however a number of issues were highlighted. Specifically, stakeholders reported a requirement for camera sites to be a minimum distance of 500 metres apart, given that the law in Belgium determines a maximum deviation of 0.3% and the induction loops used to trigger the system have a 2.5 metre inter-distance. In addition, it was reported that cameras are required to be installed at a height between 5.5 and 7 metres from the ground.

5.2.20.5 Broader issues

No broader level issues were discussed during consultations with Belgium stakeholders.

Table 5.26: Technological overview of point-to-point speed enforcement systems in Belgium.

System Component	Specific Characteristics
Cameras & Illumination	
Number of cameras	10 cameras operate as part of the system, including a camera per lane (incl. emergency lane) at both entry and exit point
Number of camera sites	2 camera sites (entry/exit) – no contiguous enforcement corridors
Camera resolution	2 Megapixels
Digital or analogue	Digital
Monochrome or colour	Colour
Camera activation	Induction loops
Forward or rearward facing	Rearward-facing
Camera per lane or multiple lanes	Designated camera per lane
Illumination approach	Infrared
Infrastructure	
Camera mounting approach	Overhead, installed on gantries
Purpose built or existing	One purpose-built, one existing (use for VMS)
Camera housing approach	IP55, protects against weather conditions and vandalism
Power source	AC
System Software & Processors	
Software characteristics	OCR (Developed by Dacolian)
Matching approach	N/A
Location of processor	ANPR processor located at the back-office
System hardware	Small industrial PC
Clock synchronisation	N/A
Size and type of image data file	1.35MB (file type N/A)
Data storage approach	Stored on the server, processed data is stored on a hard disc by Police and secured by encryption
Communications Network & Back Office	
Communication network approach	Fibre optic cables
Information captured by system	Date and time, location, captured vehicle speed, speed limit, lane position, images at entry and exit points
Degree of back-office automation	Every image of offending vehicles required to be manually checked

5.2.21 Finland

5.2.21.1 Extent of use of point-to-point speed enforcement

The Finnish trial of point-to-point speed enforcement was conducted over a five week period during August and September 2010. The trial was conducted on a 5.7 kilometre stretch of an urban single-carriageway highway, with only one direction (one lane) monitored by the system. The cameras were pole mounted on the side of the road, and the system included only a single entry and exit point. The speed limit along the monitored section was 100 km/h[35].

Although only implemented in trial form, the point-to-point system had achieved appropriate approval and certification and thus was fully enforceable during the trial period, such that some drivers received infringement notices in association with speeding offences committed. The primary obstruction to full and widespread implementation of the technology in the country was reported as being the legislative requirement for driver identification (see Section 5.3.8.4 below for more).

5.2.21.2 Technological characteristics

Unfortunately, minimal information was ascertained from the stakeholder consultations regarding the technological characteristics of the trial point-to-point speed enforcement system used in Finland.

5.2.21.3 Operational characteristics

In Finland, the Police are responsible for the operation and management of all automated speed enforcement, including point-to-point. While the Police own the technological equipment used for enforcement (e.g., cameras, etc), the Finnish Road Authority (Tiehallinto) owns the infrastructure (e.g., poles, gantries, etc), and each are responsible for the maintenance of their respective components. Thus, considerable inter-agency cooperation is necessary to ensure appropriate operation and management of the systems.

Consistent with all other speed enforcement efforts in Finland (manual or automatic), an enforcement tolerance operated during the trial. The tolerance, which is publicly known, is 3 km/h. In addition, warning letters, which carry no official penalty and no record, are sent to motorists detected exceeding the speed limit by 4 to 10 km/h[36]. These warning letters do not require driver identification, a legislative requirement in Finland in association with the administration of any infringement and penalty associated with camera detected offences.

Given that the Finnish trial system was not connected to the registration databases of neighbouring countries, it was not possible to administer infringements in association with offending motorists whose vehicle number plates were from foreign countries. However, the stakeholders reported that the proportion of foreign vehicles travelling through Finland is relatively low and that this caveat in the enforcement was not perceived to represent a major problem, particularly given that foreign motorists exceeding the speed limit were still susceptible to manual speed enforcement efforts.

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[35] In Finland, highway speed limits are typically reduced from 100km/h to 80km/h during winter to compensate for increased low-light hours. The trial was not conducted in winter, and thus the speed limit remained at 100km/h during the entirety of the trial.

[36] Fixed graduated fines are then associated with offences of above 10km/h over the speed limit and income-based ‘day-fines’ associated with offences in excess of 20km/h over the speed limit. Immediate licence suspension also exists in association with offences in excess of 40km/h over the speed limit.

The requirement of driver identification also demands a high-degree of manual back-office procedures.

5.2.21.4 Legislative characteristics

As mentioned above, there is a legislative requirement in Finland for driver identification associated with camera-detected offences. As a result, forward facing cameras were used in the trial of the technology. However, it was noted that it might be possible to use rearward facing cameras at the entry point and forward facing cameras only at the exit point. As stated earlier, the issue of requiring driver identification is a fundamental barrier to more widespread adoption of point-to-point technology in the country, such that the process of identifying the driver is time-consuming and resource-intensive, detracting from the cost-effectiveness of the approach. Stakeholders suggested that owner responsibility legislation would be needed for full implementation of point-to-point systems to be feasible.

To somewhat appease the issues associated with driver identification in the country, Finland has a relatively lengthy statutory declaration process whereby it is rather difficult for vehicle owners to nominate that they were not the driver at the time of the offence, with substantial fines for providing false information. In addition, substantial fines are also associated with the failure of companies to nominate a driver for a speeding infringement related to a company vehicle.

There is also a legislative requirement to provide motorists with warning signs in association with any fixed automatic enforcement. Such signage does not have to specifically denote that the enforcement involves the measurement of average speeds, rather it must simply inform motorists that automatic speed enforcement is used on the upcoming road section. Typically, these signs involve a camera pictogram and text warning motorists of forthcoming enforcement. This text is displayed in Finnish and often accompanied by a Swedish translation also.

Privacy regarding the images and data captured in relation to motorists and vehicles who had not committed an offence where particular issues faced prior to the trial of the technology. Approval was based on acceptance that appropriate privacy procedures were in place to protect this data, including the immediate removal of information pertaining to non-offending vehicles. However, there were provisions for data collected from the system in relation to offending drivers to be linked to other databases. Specifically, the data could be used to check if the vehicle was stolen, unregistered or linked to an unlicensed driver, or whether the registered owner of the vehicle has outstanding parking tickets or any other offences. While the data was not necessarily used for these purposes during the trial of the technology, the capability is definitely present. Moreover, the stakeholders suggested that future systems would likely utilise these capabilities, even in relation to non-speed enforcement point-to-point systems (e.g., used at parking lots).

5.2.21.5 Broader issues

Broader speed management issues: Finland currently operates fixed instantaneous speed cameras on approximately 3 000 kilometres of motorways throughout the country, with plans to expand this by a further 1 000 kilometres in the near future. Mobile speed cameras, hand-held and moving-mode radars, and traffic patrols are also conducted regularly, and fixed red-light/speed cameras are also beginning to be introduced in the country. Fixed cameras are typically installed at locations with a history of crash and speed-related problems, while other types of enforcement are used to serve a more general deterrent function.

There are hopes to expand the use of point-to-point in Finland in the future. Specifically, there are currently almost 4 000 kilometres of Finnish motorways monitored by safety cameras. There are hopes that this existing infrastructure, consisting of poles mounted to the side of the road, could be used, in association with wireless technologies, to greatly expand the use of point-to-point speed enforcement across the country. However, the stakeholders noted that the technological particulars associated with achieving this goal are yet to be reached.

The stakeholders argued that point-to-point speed enforcement systems are most efficiently used on roads with relatively high traffic volumes and reported that they believe it will be a key road safety tool in Finland in the future.

As stated previously, the greatest impediment to more widespread implementation of point-to-point speed enforcement is the legislative requirement for driver identification. The stakeholders reported that the procedure of identifying the driver and issuing infringements is a lengthy and laborious process that expends considerable resources. It was suggested that owner responsibility legislation would be needed for full implementation of the technology to be a feasible goal in the country.

Public education: Considerable public education was associated with the point-to-point trial conducted in Finland, including stories on both national and local television news. These stories typically focussed on detailing that the approach would be used, and highlighting the location in which the trial would be conducted, and were broadcast in the weeks leading up to the trial. However, some media outlets also suggested that point-to-point represented a fairer approach to speed enforcement compared to other automated approaches.

Evaluation: Stakeholders reported that an evaluation of the trial was currently being undertaken; however at the time the project was conducted the results were not yet available.

5.2.22 France

Limited information was provided by French stakeholders regarding the use of point-to-point in the country. This appeared to be the product of the planned implementation of the technology in the country and a perception that participation in the research would be premature. The stakeholders reported that the technology would be implemented in the country by September 2011.

The implementation of point-to-point speed enforcement is based on a number of issues reported by stakeholders. Specifically, at the time the research was conducted, there were strong Government-driven goals to reduce the national road toll to 3 000 fatalities by 2012 (from approximately 4 200 in 2010). To achieve this goal the Government aims to increase the number of safety cameras used in the country, with the use of point-to-point speed cameras perceived to be a more cost-effective alternative to substantial increases in the number of fixed instantaneous speed cameras (although the number of fixed speed cameras, mobile speed cameras and red-light cameras are also expected to increase). Indeed, stakeholders reported the use of approximately 3 000 safety cameras in the country. It was suggested that the motoring public typically hold negative attitudes toward instantaneous speed enforcement approaches and thus point-to-point may represent an approach that is perceived to be fairer.

Stakeholders suspected that the upcoming implementation of the technology would represent a technological and operational feasibility trial, such the technology is tested and the appropriateness of locations for use of the approach fully assessed. A number of issues were raised regarding the ability to use point-to-point speed cameras on sections of road with more than one speed limit, without the use of contiguous enforcement corridors at the location of the speed limit change.

In addition to the stakeholder consultations, prior research also shed light on previous trials of point-to-point speed camera use in France. Specifically, two previous trials of the technology are noted: the first on the A16 at Junction 18 in August 2003 during roadworks near Amiens, and the second on the A7 motorway near the Rhone valley between July and September 2004 on a 90 kilometre stretch of road between Orange and Valence (Schwab, 2006; Speed Check Services, 2004). While the technology employed was relatively similar to that used in other countries, neither trial involved an enforcement component. Instead, variable message signs are used to display the licence plate number and speed of offending vehicles as well as a warning to slow down, such that the systems were intended to serve as a deterrent by reminding drivers of their speed.

5.2.23 Other countries

Limited information is available on the use of point-to-point speed enforcement in other European countries. Stakeholder consultations revealed that the technology is currently being used or trialled in Norway and the Czech Republic. In addition, information identified during this research suggests the technology is currently being trialled in Spain.

Indeed, the literature suggests that in 2006, point-to-point speed enforcement was being utilised at approximately 20 sites located in tunnels and urban roads throughout the Czech Republic (Kuratorium fur Verkehrssicherheit, 2007). In addition, it has been reported that a technical feasibility trial was conducted in Norway on a 2.8 kilometre section of road near Lillehammer in 2005-2006 (Simcic & Townsend, 2008). However, stakeholder consultations revealed that a number of privacy issues were currently being dealt with in Norway regarding the collection of data (including images) in relation to individuals who had not yet committed an offence.

Despite claims that the technology has been used on some high-speed motorway networks in Slovenia since 2005 (Townsend & Achterberg, 2005), Slovenian stakeholders reported no such use of the technology, despite highlighting that the approach is being seriously considered.

Finally, consistent with the minimal use of fixed and mobile speed camera use in the United States, there currently appears to be no use of point-to-point speed enforcement at the time of the research.

6. RECOMMENDATIONS FOR BETTER PRACTICE

Based on the findings reported from the stakeholder consultations, working group and literature review, a number of recommendations for better practice are suggested in relation to the development and implementation of point-to-point speed enforcement systems in Australia and New Zealand. These are presented under the headings of: (i) operational recommendations; (ii) technological recommendations; (iii) legislative recommendations; (iv) public education recommendations; (v) evaluation recommendations; and, (vi) privacy recommendations.

6.1 Operational recommendations

Recommendation 1: The selection of sites for the implementation of point-to-point speed enforcement should be based on strict criteria aimed at achieving road safety benefits and ensuring cost-effectiveness of the point-to-point speed enforcement systems. Jurisdictions should work together to develop and refine site selection methodologies.

Similar to the selection of enforcement locations for other approaches to speed enforcement, site selection for the use of point-to-point speed enforcement systems should be based on strict criteria aimed at achieving key road safety outcomes. In addition, consideration should be given to ensuring point-to-point speed enforcement systems are cost-effective, however the underlying goal of implementation of the technology should not be to raise revenue from infringements.

International and domestic stakeholder consultations revealed that there are already a range of criteria used for determining the locations used for point-to-point speed enforcement. While such criteria will invariably differ between jurisdictions, it should at least include crash history (supported by relevant crash data), speed profiles that are designated as high risk or excessive (supported by relevant speed data), the proactive identification of potential crash sites (such as around new developments with increased traffic volume), or locations where other forms of enforcement are not safe or viable (e.g., in tunnels).

Regarding crash history, such crashes should have occurred along a section of road, rather than at a single location which may be more efficiently enforced using fixed or mobile speed cameras or manual approaches. In addition, the contribution of speed to these crashes should be assessed, such that non-speed-related crashes may be largely unaffected by the use of point-to-point speed enforcement. That said, the underreporting of speed as a contributing factor in traffic crashes has been highlighted (Robinson & Singh, 2006) and there is considerable evidence that speed cameras affect all types of casualty crashes (Wilson, Willis, Hendrikz, Le Brocque, & Bellamy, 2010). Speed-related problems, observed or anticipated, also represent an important criterion, particularly in relation to the use of systems on road sections where speed limits have been reduced (e.g., roadworks zones).

It is also recommended that locations where point-to-point speed enforcement is implemented should have relatively high traffic volumes, no major foreseeable infrastructure changes planned for the section, and proximity to mains power. In addition, site selection should consider the implications of drivers seeking alternative routes on traffic congestion and the displacement of road safety issues.

Most jurisdictions use crash data and speed profiles as a basis for site selection; however limited information is available regarding the specific methodologies employed. It is recommended that jurisdictions work together to develop and refine methodologies used to identify appropriate enforcement sites. This may include the calculation/estimation of BCRs associated with various sites and examination of the likely effectiveness and efficiency of point-to-point as an enforcement countermeasure relative to other countermeasures (e.g., fixed and mobile instantaneous speed cameras). Irrespective of the approach adopted, the goal should be on identifying the road safety benefits associated with the implementation of point-to-point systems at various sites. Limited emphasis should be placed on infringement rates/revenue as point-to-point systems are unlikely to result in high detection rates and revenue generated from infringements is unlikely to be high. For an example of a more systematic approach to identifying the most appropriate sites for point-to-point speed enforcement implementation see Cameron (2008).

That said, there should be flexibility for jurisdictions to determine their own needs and uses of point-to-point speed enforcement and select sites accordingly. For example, jurisdictions should have the flexibility to decide the level of involvement of key stakeholders (e.g., local governments, motoring groups) in the process of site selection.

Recommendation 2: Point-to-point speed enforcement should be strategically used in conjunction with existing automated and manually-operated speed enforcement approaches in order to promote greater compliance with posted speed limits across larger sections of the road network.

The use of point-to-point speed enforcement should be complementary to other automated and manually-operated approaches to speed enforcement, rather than being viewed as a replacement for existing efforts. Determining the optimal mix of various approaches is beyond the scope of this report and is likely to vary substantially between and within jurisdictions, based on numerous road network and socio-political factors. However, the overwhelming consensus from stakeholder consultations and prior literature suggests that point-to-point speed enforcement has the potential to produce significant positive road safety benefits, provided that it is implemented and maintained in an appropriate manner. These safety benefits primarily involve reduced vehicle speeds and traffic crashes; however may extend to improved traffic flow, reduced congestion and journey times, and reduced vehicle emissions and noise.

Historically, point-to-point speed enforcement has typically been implemented on urban and rural highway/freeway/motorway settings in those countries using the technology. In Australia in particular, there has been a tendency for the use of the approach on more regional/rural sections of highway. As a function of the geographic characteristics in a number of Australian jurisdictions, enforcement on more remote sections of road is typically infrequent and the use of alternative approaches to speed enforcement may not be feasible. Thus, it is suggested that point-to-point speed enforcement may represent a particularly useful approach to speed management on rural roads with relatively high traffic volumes or with particular safety concerns (e.g., popular heavy vehicle routes). Indeed, the New South Wales Auditor General's report (Auditor-General New South Wales, 2011b) into young driver safety recommended the use of point-to-point speed enforcement in rural areas.

However, the use of point-to-point speed enforcement in urban/residential environments should be further explored. Indeed, the use of the approach on urban arterial roads and residential streets is increasing, particularly in the United Kingdom. The proposed roll-out of point-to-point enforcement in the ACT also involves implementation on urban arterial roads. Such applications of the technology should be monitored and evaluated, including outcome, process (e.g., technological feasibility) and cost-effectiveness to further inform the utility of point-to-point speed enforcement on lower-speed urban roads.

Recommendation 3: Point-to-point speed enforcement should not represent a long-term alternative to addressing underlying road design or maintenance deficiencies on sections of road, which would be better addressed through engineering solutions.

During the site selection process, locations identified as having a high crash history should be appropriately assessed to ensure that a more viable and cost-effective alternative road engineering solution is not available to address the road safety problem. If such solutions are available, the implementation of point-to-point speed enforcement systems should be avoided. However, point-to-point speed enforcement systems may represent an appropriate temporary response while underlying road layout issues are addressed. In addition, point-to-point can be complementary to improved road conditions and road safety treatments, such that it can ensure compliance with safe design speeds, a critical element of the safe systems approach.

Recommendation 4: Point-to-point speed enforcement systems should be implemented with the capacity to monitor all vehicle types, even if the initial implementation does not require this capability, and where feasible, should be used to monitor all possible vehicle types.

It is recommended that point-to-point speed enforcement systems should be implemented with the capacity to monitor all vehicle types, irrespective of the intended requirements of the system upon installation. Indeed, the adoption of various approaches can reduce the scope of vehicles monitored by the system (e.g., forward or rearward facing cameras). Such a recommendation ensures that, should the decision be taken in future to extend the program to other vehicle types, the system has been designed in such a way that it is functionally able to meet this demand.

It is also recommended that, where feasible, point-to-point speed enforcement systems are used to monitor all possible vehicle types, thus achieving maximum road safety benefits and impacts on the speeding behaviour of a greater proportion of motorists. An important related consideration, however, is that different crash profiles for different vehicle types may necessitate the use of different infrastructure requirements across vehicle types. For example, the location of point-to-point camera installations to address heavy vehicle crashes/speeding may be different to the locations needed to address motorcycle or light vehicle crashes/speeding. Therefore, there is need to balance system requirements for one type of vehicle with overall functionality across multiple vehicle types.

Recommendation 5: Point-to-point speed enforcement systems should (continue to) be operated overtly, including: advance signage placed prior to the enforcement corridor that highlights the extended nature of enforcement activities; additional reminder signs located within the enforcement corridor for longer sections (e.g., five kilometres or longer); and, no signage to signify the end of the enforcement corridor.

It is recommended that signage be used in and/or within the enforcement corridor, in order to promote awareness among the general driving community of this relatively new type of speed enforcement technology. No strict recommendations are made regarding the precise content to be displayed on the signs, given that contextual differences in system operations from jurisdiction to jurisdiction will affect content requirements (e.g., whether the system measures average speed, instantaneous speed or both). However, where feasible, it is recommended that signage highlight the extended nature of enforcement activities (e.g., ‘Average Speed Cameras’, ‘Speed Cameras Next XX kms’).

While point-to-point speed enforcement has been shown to effect behaviour over a greater length (compared to fixed instantaneous or mobile speed cameras), it is acknowledged that limited information is known regarding the halo effects associated with the approach. As such, location-specific signage may produce only localised compliance and it is therefore recommended that consideration be given to the use of speed enforcement warning signage installed more generally across the entire road network, including locations where point-to-point systems are not used, in order to increase the general deterrent impact of existing point-to-point systems. In addition, it is recommended that no signage be adopted that signifies the ‘end of enforcement’, to further increase the general deterrent effects and halo effects associated with the enforcement approach.

At present, jurisdictional requirements differ within Australia and New Zealand regarding whether advance warning signage associated with speed cameras (including point-to-point) is a legislative requirement or an operational policy requirement. All current installations of point-to-point speed enforcement in Australia (and anticipated systems in the Australian Capital Territory and New Zealand) employ signage prior to the commencement of the enforcement corridor; however this typically represents a policy requirement, rather than legislative requirement. The current report finds no evidence to recommend a deviation from such current practices until clearer evidence emerges regarding the relative effects of different approaches.

Given the relative infancy of point-to-point speed enforcement in Australia and New Zealand, it is recommended that such systems be operated with a high degree of visibility, to provide motorists with the opportunity to become familiarised with the approach. Overt operation of the systems is also likely to increase the general deterrent impact associated with the technology. Currently, all trial and full installations of point-to-point systems in Australia and New Zealand are operated overtly.

Recommendation 6: Each jurisdiction should be responsible for managing the enforcement tolerances associated with point-to-point speed enforcement systems according to their own jurisdictional needs.

While all Australian and New Zealand jurisdictions operate enforcement efforts with some degree of tolerance, such levels are not publicly disclosed. In addition, there is some variation in the level of tolerance adopted for point-to-point speed enforcement, compared to other automated and manually operated approaches to speed enforcement. It is acknowledged that each jurisdiction faces unique challenges, both historical and policy related, associated with setting enforcement thresholds. As such, it is recommended that each jurisdiction should be responsible for managing the enforcement tolerances associated with point-to-point speed enforcement systems according to their own jurisdictional needs. Given the lack of sufficient current evidence, no recommendations are made regarding the use of different tolerances for point-to-point compared to other approaches.

Recommendation 7: All jurisdictions should have a multiple infringement policy that clearly stipulates how multiple infringements are dealt with, however such a policy should not necessarily prescribe that only one infringement can be issued for multiple offences.

There are numerous instances in which a motorist may be administered with multiple infringements in relation to a single trip through a single point-to-point enforcement system. For instance, systems can be designed with the capability to measure and enforce both average and instantaneous speeds, systems may involve contiguous enforcement corridors, or additional enforcement may be conducted within the enforcement corridor. For this reason, numerous jurisdictions throughout the world, and within Australia and New Zealand, have created multiple infringement policies (or had existing policies) in relation to the implementation of point-to-point speed enforcement. The most common approach to multiple infringement policies is to administer only a single infringement to offending motorists, typically in relation to the most severe of all detected offences. However, it is noted that a number of Australian jurisdictions allow for multiple infringements to be issued within a single point-to-point system, particularly in relation to more serious offences.

It is recommended that all jurisdictions should have a multiple infringement policy that clearly stipulates how multiple infringements are dealt with, however such a policy should not necessarily prescribe that only one infringement can be issued for multiple offences. Indeed, it is recommended that policies aimed at protecting drivers from receiving multiple infringements be restricted to low-level speeding offences only, and that provisions be made to administer multiple infringements to motorists who have committed continued and persistent excessive speeding offences.

Where it is not feasible to introduce such policies whereby multiple infringements can be administered, it is recommended that more serious offences are given priority. Specifically, given the more sustained nature of speeding behaviour performed in order to commit an average speed offence, consideration should be given to prioritising an average speed offence as more serious than an instantaneous speed offence, and where multiple infringements of the same offence are detected (e.g., more than one average speed offence across contiguous sections) that priority be given to the offence associated with exceeding the posted speed limit by the greatest amount.

Recommendation 8: Police should continue to conduct routine traffic patrols within the enforcement corridor aimed at monitoring illegal, high-risk driving behaviours other than speeding. This is particularly relevant for longer sections.

It is recommended that jurisdictions do not treat the implementation of point-to-point speed enforcement systems as a ‘silver-bullet’. Indeed, there is limited evidence to suggest that the approach has a substantial impact on other illegal, high-risk driving behaviours (e.g., failure to wear restraints, drink and drug driving). Thus, routine patrols should continue to be conducted within the enforcement corridor, particularly when the enforcement corridor is relatively lengthy. It is acknowledged that additional policing within the point-to-point enforcement corridor assists in promoting the message that enforcement is not limited solely to average speed offences.

As a side note, no recommendation is made regarding the simultaneous use of point-to-point speed enforcement systems for the measurement and enforcement of both average and instantaneous speeds. There is currently insufficient evidence to make such recommendations and as such decisions should be left up to each jurisdiction based on the perceived need to also measure instantaneous speeds at each camera site.

Recommendation 9: Excessively long distances between camera sites should be avoided, particularly when there are many opportunities for access and egress within the enforcement corridor. When lengthy enforcement corridors are desired, contiguous enforcement corridors should be used.

While it is recommended that excessively long distances between camera sites be avoided, no specific recommendation is made regarding the specific maximum distances between camera sites. Instead, it is suggested that such decisions be based on access and egress opportunities and the impact such opportunities have on throughput traffic for the enforcement corridor, and in turn the proportion of vehicles monitored by the system. This recommendation is less important in stances where there are fewer opportunities or incentives for access and egress within the enforcement corridor, however the impact of changes to the road environment (e.g., re-surveying shortest practicable distance) on longer enforcement corridors should be considered.

Recommendation 10: The decision to use point-to-point speed enforcement systems on road sections with multiple speed limits should be accompanied by appropriate legislation that includes the identification of an average speed offence and related issues and should be guided by the current context of speed management in the jurisdiction.

If a point-to-point speed enforcement system is to be implemented across non-discrete speed zones, the appropriate legislative checks and balances must be ensured. This may involve the need to create a separate ‘average speed limit’ in the legislation (as currently done in New South Wales), and will have implications for the surveying of shortest possible distances. Indeed, such an approach increases the importance associated with identifying changes within the enforced section which may affect the road alignment, and hence the shortest practicable distance, and suggests the need for stringent management processes to be developed.

However, it should be noted that given the complexity associated with measuring average speeds across non-discrete speed zones, stakeholders from various jurisdictions considered the use of point-to-point speed enforcement systems across non-discrete speed zones as problematic, even if they perceived the approach to be technically feasible. Appropriate communication to the motoring public of the formula used to measure average speeds would be critical in ensuring the legitimacy of the enforcement approach is maintained.

Recommendation 11: Unless contiguous enforcement corridors or multi-point systems are used, point-to-point speed enforcement systems should not be installed along road sections where there are features (e.g., service stations, rest stops, traffic lights) that increase the likelihood that a vehicle will exit the road or be stopped, or not monitored by the system (e.g., exit and entry roads).

The implementation of point-to-point speed enforcement systems should consider the impact of various features within an enforcement corridor that may affect the proportion of vehicles effectively monitored by the system. As a starting point, the opportunities for access and egress (e.g., the number of exits/entering roads) within the enforcement corridor should be minimal. However, if the majority of vehicles represent throughput traffic along the enforced section, and drivers attempting to circumvent the system by using exits to avoid enforcement would be disadvantaged by doing so (e.g., substantial additional travel distances/time), than exit ramps and entering roads will only slightly impact on the efficiency of the system.

Arguably more critical to the overall efficiency of the system are factors such as rest-stops, service centres, traffic lights, or other speed reduction design elements (e.g., speed bumps, chicanes, etc). Such features serve to increase the variation in vehicle speeds throughout the enforcement corridor and thus reduce the accuracy of overall average speed measurements, such that compliance cannot be ensured across the entire monitored section. To mitigate problems associated with such features, contiguous enforcement corridors or multi-point systems (see Glossary) are recommended, such that additional camera sites are located prior to and/or following such features.

Such a recommendation is particularly relevant to the use of point-to-point speed enforcement systems in more urbanised areas. Using the recent implementation of the RedFusion system on the A13 in London involving 37 cross-referenced camera sites as an example, it is clear that the problems associated with using point-to-point along sections of road with such features can be mitigated using a multi-point system approach.

Recommendation 12: Point-to-point enforcement systems should monitor and enforce all traffic lanes, including, where it is deemed necessary, emergency lanes and traffic lanes travelling in the opposite direction, with penalties associated with attempted avoidance behaviours.

To ensure certainty of punishment associated with the approach, point-to-point speed enforcement systems should monitor and enforce all lanes of traffic. In addition, consideration should be given to monitoring vehicles travelling in emergency lanes and traffic lanes travelling in the opposite direction, given that such behaviour has been highlighted as a punishment avoidance strategy. Moreover, consideration should be given to ensuring division between directions of traffic flow (e.g., via the use of median strips, guardrails) at each camera site to prevent vehicles avoiding detection by crossing to the opposite side of the road. To further deter such behaviour, penalties for attempted avoidance behaviours should be implemented and made publicly known.

Recommendation 13: Mobile point-to-point speed enforcement systems should be developed, trialled and evaluated to determine their capability and effectiveness.

Stakeholder consultations revealed significant interest in the use of mobile operations for a number of reasons. First, the use of mobile operations provides additional flexibility to enforcement capability because they can be installed at locations with road safety concerns (e.g., roadworks sites with reduced speed limits) at significantly less cost and in a timelier manner than a permanent point-to-point system. Second, the approach was noted as potentially able to increase the deterrent effect of existing mobile speed camera operations because motorists would be unsure when passing a mobile speed camera van whether they were passing a camera operating in isolation or as part of a system that will measure average speed between two points. This may, therefore, encourage motorists to comply with posted speed limits across greater segments of the road network, particularly if used in conjunction with existing programs and randomly scheduled across sites. Finally, given perceptions of unfairness held by some sections of the community towards the measurement of instantaneous speeds (i.e., spot speed measurement by current mobile and fixed speed camera operations), the use of mobile (and permanent) point-to-point systems may assist in promoting greater community acceptance of this form of speed enforcement.

Recommendation 14a: Prior to release, new number plate designs should be tested to ensure existing camera equipment used within the jurisdiction is capable to sufficiently detecting and capturing the plate for enforcement purposes.

Recommendation 14b: Vehicle number plates should avoid using glossy numerals and letters or a glossy background.

Recommendation 14c: Identical alpha-numeric sequences should not be used within or across jurisdictions, irrespective of the design of the number plate.

The ability to accurately detect and capture vehicle number plates is a basic requirement for all automated speed enforcement systems. Considerable variation in number plates, both within jurisdictions and at the national level, was reported as a major limitation to the efficient operation of automated enforcement, including point-to-point speed cameras. It is recommended that all feasible efforts be made to ensure uniformity of the letters and numeral sequences on number plates and on ensuring existing speed monitoring equipment is capable of detecting and capturing number plates. While it is acknowledged that some duplication has already occurred within Australia, it appears to have been manageable to date, however it is suggested that further duplication should be avoided to negate potential negative impacts on enforcement efficiency.

It is recommended that all feasible efforts be made to ensure uniformity of the letters and numeral sequences on number plates and on ensuring existing speed monitoring equipment is capable of detecting and capturing number plates. Efforts to support harmonisation of number plates within and across jurisdictions are supported by findings of the current research.

6.2 Technological recommendations

The following technological recommendations must be considered in light of the various approaches available and the continually evolving nature of the technology associated with point-to-point speed enforcement systems. That is, it is acknowledged that various approaches to the technological characteristics of point-to-point systems are capable of achieving effective enforcement and appropriate system efficiency in a cost-effective manner. While, these recommendations attempt to outline current best practice (based on available information), it is acknowledged that the adoption of alternative approaches do not necessarily reflect poor practice. In addition, it is acknowledged that future advancements and developments in the technology associated with point-to-point enforcement are likely to further enhance the effectiveness and efficiency of systems.

Recommendation 15: Designated cameras should be used for each individual lane.

To ensure that all vehicles entering the enforcement corridor are monitored, it is recommended that a designated camera is used to monitor each individual lane of traffic of in the enforced section. In addition, at noted in Recommendation 13, where deemed necessary, it is also recommended that cameras be used to monitor emergency lanes, to increase detection of motorists attempting to circumvent enforcement efforts.

Recommendation 16: Where feasible, both plate and scene cameras should be used.

The use of both plate and scene cameras increases the accuracy of point-to-point speed enforcement systems. At minimum, systems must include plate cameras with sufficient resolution to accurately recognise the letter and numerical sequences of captured number plates (both using the ANPR/OCR software and by human verification). The additional use of scene cameras provides verification of a variety of road environment factors, such as lane position and vehicle characteristics, which may have important implications for evidentiary purposes (e.g., in instances when an infringement is challenged).

Recommendation 17: Whenever feasible, both forward facing and rearward facing cameras should be used to ensure all vehicles (including motorcycles) can be monitored by the system. If not feasible, the decision should be based on the jurisdictional requirements regarding the vehicles targeted by the system.

While it is acknowledged that the use of both forward and rearward facing cameras offers optimal vehicle capture rates, such an approach is associated with significantly greater infrastructure costs and system requirements (due to the generation of greater amounts of data and subsequent back-office processing). As such, decisions regarding camera direction must consider which types of road users are to be detected by the system. In Australia and New Zealand, motorcycles are currently only detectable via rearward facing cameras due to the requirement for them to only display a number plate on the back of the vehicle. However, rearward facing cameras are associated with a number of factors that reduce detection rates (e.g., trailers/caravans, spray from rear tyres on wet road surfaces). Where the enforcement of speeding motorcycles are most important, the use of rearward facing cameras is recommended, while for other vehicle types, including heavy goods vehicles, the use of forward facing cameras is recommended.

Recommendation 18: Digital cameras should be used, with the specific resolution of the cameras balancing requirements of the clarity of images for evidentiary purposes with system capabilities.

The use of digital technology is undoubtedly a more efficient and cost-effective approach to traditional approaches (e.g., analogue video, wet-film) and often provide better image resolution. However, with increased resolution comes a need to balance system capabilities regarding the processing and storage of captured images. The fundamental aim should be to ensure optimal resolution of the captured image for evidentiary purposes within reasonable bounds of system capabilities. In addition, the use of digital technology also facilitates greater integration into existing systems and future expansion of system functionalities. That said, the use of digital technology requires appropriate security protocols that ensure the authenticity of the captured image and protect images from manipulation and tampering.

Recommendation 19: Monochrome cameras and infrared flash should be used.

While numerous approaches can be adopted and used in a manner which will have limited impact on system effectiveness, it is recommended that the most appropriate approach is the use of monochrome cameras and infrared flash. Advantages to this approach include the compatibility of the approaches and the fact monochrome cameras are typically more sensitive and require lower levels of ambient light.

Recommendation 20: Camera activation systems should be rigorously tested prior to use to ensure appropriate degrees of accuracy in detecting vehicles passing the camera site. Consideration must also be given regarding how invasive the approach to camera activation is, in terms of disturbance to the road environment.

Whatever approach to camera activation is adopted, it is recommended that rigorous testing be conducted prior to use to ensure appropriate accuracy of the method, such that the system detects, and thus monitors, the vast majority of vehicles entering the enforcement corridor. Moreover, consideration should be given for the degree to which the activation approach is invasive, such that traffic disruptions will occur during implementation and maintenance. Accordingly, the use of laser triggers as the camera activation approach may be more efficient given that such an approach requires less disturbance of the road surface, as in the case of induction loops. However, numerous approaches of varying degrees of invasiveness have been reported as effectively and efficiently activating cameras.

Recommendation 21: Decisions regarding the approach to camera housing/mounting should consider the scope of weather conditions experienced and anticipated vandalism in the jurisdiction.

A range of approaches to camera housing are available, each offering various levels of protection from weather conditions and vandalism. While vandalism was not noted as a significant issue in terms of the number of episodes in Australian and New Zealand jurisdictions experienced to date, it is recommended that steps be taken to protect point-to-point speed enforcement infrastructure from vandalism and related potential breaches of system integrity. Specifically, camera housing should provide sufficient protection and camera equipment should be installed as high as possible from the ground on infrastructure that restricts general access.

Recommendation 22a: Where feasible, overhead mounting should be used. When side-mounted poles are used: poles should be located such that roadside clutter and potential hazards are reduced; infrastructure (e.g., guardrails) should also be installed to protect motorists; and, cameras should be installed at an appropriate height off the ground to minimise loss in capture rates.

Recommendation 22b: Future research should seek to quantify the impact of camera mounting approach (overhead versus side-mounted) on capture rates.

Recommendation 22c: The development and trial of roadside cantilevers with arms that extend over the traffic lanes should be explored.

Unfortunately, there is little information that precisely quantifies the reduction in capture rates associated with side-mounted pole installations compared to overhead installations of camera equipment. Intuitively, it can be expected that overhead camera installations will be less susceptible to instances where larger vehicles (e.g., trucks, buses) obstruct the view of the camera from detecting other vehicles compared to side-mounted approaches. However, the extent to which such impacts on capture rates justify the substantial increase in infrastructure costs associated with overhead installations remains unclear. Thus, it is recommended that future research should address this issue.

Moreover, the development and trial of roadside cantilevers (as used in the United Kingdom) should be conducted in the Australian and New Zealand context. Such an approach allows for the benefits of overhead installation, while substantially reducing infrastructure costs. However, consideration of structural and design issues, such as vibration from passing vehicles and the effects of movement from wind, must be considered for effective and reliable implementation of such an approach.

Recommendation 23: Installation of a point-to-point speed enforcement system should consider maintenance requirements, such that it is ensured that system maintenance results in minimal, if any, disruptions to traffic flow at the camera site.

Forethought is required when installing point-to-point speed camera systems to ensure appropriate access to all technological components for the purposes of repair and maintenance with minimal (if any) disruption to the flow of traffic. This is particularly relevant in association with overhead installations, such that falling objects (e.g., tools) may present significant hazards to road users.

Recommendation 24: Where feasible, ANPR/OCR processing should be conducted at the location of the camera site to minimise the amount of data that is required to be transmitted through the communication network.

It is recommended that, where feasible, ANPR/OCR processing be conducted at the location of the camera site (e.g., roadside cabinet, housed with the camera equipment). Such an approach ensures the most efficient operation of the system, such that only data on offending vehicles need be transmitted to the back-office via the communication network. However, if the system has sufficient capabilities to transfer the necessary data associated with the traffic volume of the enforced section, such a recommendation is not critical and ANPR/OCR processing can effectively and efficiently be conducted at the back-office, although privacy and security assurances associated with the transmission of data must be considered.

Recommendation 25: ANPR/OCR software should be rigorously tested prior to use to ensure appropriate degrees of accuracy regarding both plate recognition (e.g., detecting a vehicle's number plate in the captured image) and plate reading accuracy (e.g., degree to which the correct number/letter sequence is identified and the consistency or errors across images from various points in the system).

The accurate recognition of letter and numerical sequences from captured images by the ANPR/OCR software is the most fundamental element of the number plate reading process. Rigorous testing must ensure that the software is capable of reading the variety of number plates used within the jurisdictions, as well as other jurisdictions (see Recommendations 15a-c). In addition, it is fundamental that, when errors are made by the ANPR/OCR engine, they are consistent at both the entry and exit site. Such errors still allow for the enforcement of that vehicle, although highlight the need for some degree of manual verification at the back-office (see Recommendation 29). Conversely, when errors differ between the entry and exit sites, offending vehicles are not detected, thus reducing the enforcement effectiveness of the system.

Recommendation 26: The amount of information captured by a system should be as extensive as feasibly possible and include, at a minimum: images from at least two camera sites; average vehicle speed; speed limit (which might include enforcement tolerance); date and time of infringement; and location of camera sites.

There are numerous options regarding the level of detail of information that can be collected by a system. At minimum, the system must collect the following data: images from at least two camera sites; average vehicle speed; speed limit (which might include enforcement tolerance); date and time of the infringement; and, location of the camera sites. In addition, a system should aim to collect data including: lane positioning; direction; operator/device details; vehicle classification; GPS coordinates; and, components data (e.g., log of system checks of various components).

Recommendation 27: Appropriate security protocols should be developed to prevent unauthorised access to data and protect the transmission of data.

A number of proposals for ensuring the security of data are recommended including: sufficient encryption to ensure integrity of evidence chain during data transmission; access control rules and access logs; and, mechanisms to protect roadside processors (e.g., physical reinforcing, alarm systems). It is recommended that such safeguards automatically deactivate the system when unauthorised access is detected and immediately delete all data.

Recommendation 28: All images and details associated with infringements detected by point-to-point enforcement systems should be manually verified during the back-office process.

It is recommended that back office processing of point-to-point speed camera detected offences employ human verification checks of all data on which infringements are based on, particularly images used to identify vehicle registration details. No system is 100% accurate and thus errors may eventuate, such as when a number plate is incorrectly read at both entry and exit points of the system. Such errors serve to erode public confidence in the integrity of point-to-point systems and thus should be avoided.

6.3 Legislative and evidentiary recommendations

Recommendation 29a: Legislation of point-to-point systems should cover, at a minimum: prescribed device; prescribed process; surveyed shortest practicable distance; synchronisation of the time clocks; definition of the data (e.g., formula used to calculate average speed); and, measurement of average speed as evidence of actual speed.

Recommendation 29b: Shortest practicable distance should be: assessed by an independent and certified surveyor using measurement methods that are traceable to national standards of distance measurement; resurveyed following any changes to the road alignment or associated infrastructure within the enforcement corridor that may affect this distance.

Recommendation 29c: Clocks associated with point-to-point speed enforcement systems should be: synchronised with a single common time source; include a secondary reference system; be synchronised regularly, with a log of drift times recorded; use measurements that are traceable to national standards of time measurement; be regularly tested and certified; and, include safeguards to ensure the accuracy of clock synchronisation.

A legislative framework associated with the introduction and approval of point-to-point speed enforcement should cover all aspects of the system. Specifically, it should be ensured that the enforcement device is appropriately gazetted and approved. In addition, the processes involved in the administration of infringements associated with offences detected by the system (such as the specific formula used to calculate speed and the collection and integration of data from two or more detection devices) should also be appropriately approved. It is also necessary to ensure that measurement of average speed can be used as prima facie evidence of actual speed.

In addition, a number of recommendations are made regarding the surveying of shortest practicable distances and synchronisation of time clocks associated with point-to-point speed enforcement systems. Shortest practicable distances should be assessed by independent and certified surveyors using traceable measurement methods. In addition, it is critical to the accuracy of the system that this distance be resurveyed following any changes to the road alignment or associated infrastructure within the enforcement corridor that may affect this distance. Time clocks should be synchronised with a single common time source (using traceable measurements), with a secondary reference system used to ensure accuracy and safeguard against malfunctions. It is critical for synchronisation to be performed regularly (with drift logs recorded), and for this component of the system to be regularly tested and certified. The use of a secondary reference system is currently being set up in Victoria, is being implemented in association with the New Zealand trial and is used in most installations in the United Kingdom.

It is recognised that Australian and New Zealand jurisdictions have developed their own stringent surveying and certification procedures out of necessity, in the absence of specific guidance from national-level bodies. The need for appropriate legislative guidance in certification and testing of all aspects of point-to-point speed enforcement systems at the individual jurisdictional level has led to a piecemeal and segmented array of requirements, which represent a barrier to attaining testing and certification benchmarks at the national level.

Recommendation 30: Maintenance schedules, calibration/testing and recertification should be conducted at least annually to ensure system accuracy and support the integrity of prosecutions.

It is recommended that mandatory maintenance schedules, calibration and/or testing, and recertification procedures be instituted that require such tasks to be conducted at least annually, although it is strongly recommended that performing such tasks as regularly as feasibly possible would be associated with greater system efficiency. Calibration and testing of equipment may include the time clocks, camera and flash, ANPR/OCR software or camera activation approach and may involve qualified experts or be self-tested. The use of data logs where appropriate may aid this process. It is suggested that each jurisdiction be responsible for the decision regarding whether such requirements be legislated or administered at a policy level. Such requirements would facilitate ongoing accuracy of the system and support the integrity of prosecutions associated with the technology.

6.4 Public education recommendations

Recommendation 31a: Public education should increase awareness among the motoring public regarding the rationale for point-to-point speed enforcement systems, in order to enhance the general deterrent effect of the technology. Other issues addressed might include a basic overview of how the approach operates and the extent of operations.

Recommendation 31b: Public education should involve the availability of sufficient information regarding the point-to-point system on the websites of relevant stakeholders. Where feasible, other common media outlets (e.g., newspapers, radio and television) should also be utilised to educate the driving public about point-to-point speed enforcement systems.

There is growing evidence showing that point-to-point enforcement is associated with exceptional rates of compliance with speed limits. In addition, the approach is widely considered to be an important mechanism for dealing with persistent, intentional speeders. Thus, point-to-point speed enforcement represents an effective approach to speed management that increases both the general and specific deterrence associated with enforcement efforts and should be described as such in education campaigns. In addition to the deterrent effects of the enforcement approach, other issues addressed in media campaigns might include a basic overview of how the approach operates, the extent of operations and addressing the cost-effectiveness of the approach to abate any perceptions regarding the expensiveness associated with the approach.

It is also noted that some jurisdictions have described point-to-point speed enforcement as a ‘fairer’ approach given that it monitors speeding behaviour over a longer period of time, thereby negating the argument sometimes used by drivers that their speeding behaviour was inadvertent and only performed for a short period. However, it is recommended that the use of the term ‘fairer’ be avoided, given that it may send an inappropriate and inaccurate message to the public that other forms of speed enforcement are not fair or less fair. That is, any discussion of the fairness of point-to-point enforcement should avoid doing so in terms of the relative fairness compared to other approaches.

It is recommended that the communication of information to the motoring public should use the most appropriate mediums available to reach the target market of the education efforts. This is likely to vary between jurisdictions.

6.5 Evaluation recommendations

Recommendation 32a: Point-to-point speed enforcement systems, whether implemented in trial or fully enforceable form, should be evaluated.

Recommendation 32b: Evaluations should include outcome, process, driver acceptance and cost-benefit evaluations and involve rigorous methodologies (e.g., matched control sites, statistical significance testing, control for confounding factors, sufficient baseline and follow-up data periods).

Recommendation 32c: The cost of conducting evaluations should be factored into project development costs.

The evaluation of point-to-point speed enforcement systems is critical, particularly in light of the limited number of rigorous and scientifically sound evaluations conducted to date. Outcome, process, driver acceptance and cost-benefit evaluations should be conducted and rigorous scientific methodologies should be adopted, including: the inclusion of matched comparison sites; statistical significance testing; control for confounding factors; and, sufficient baseline and follow-up data periods.

Key data to be used in any outcome evaluation of the effectiveness of point-to-point enforcement will depend to the particular application and purpose for which the technology was implemented. At a minimum, the impact of the approach on crash data (e.g., fatal and serious injury crashes, minor injury crashes, property damage only, effects on crash frequency and severity) and speed profiles (e.g., average speeds, 85^{th} percentile speeds, proportion of vehicles exceeding the speed limit, impact on proportion of vehicles excessively speeding, speed variability) should be assessed, along with the cost-effectiveness of the approach. Additional road safety and public health outcomes might also include (but are not limited to) the impact of the approach on: vehicle headway; traffic flow, congestion and journey times (on both primary and secondary networks); vehicle emissions and noise; and rates of driver acceptability of enforcement.

Given that program evaluation can be expensive such costs should be factored into the project development. A number of issues should be of particular interest to researchers, including (but not limited to): an investigation of the halo effects associated with point-to-point systems; examination of the impact of point-to-point in rural versus urban environments and different road types (e.g., freeway/highways, arterial roads, residential streets); an assessment of the impact of side-mounting camera equipment on capture rates; assessing both crash frequency and severity; and the implications of drivers seeking alternative routes on traffic congestion and the displacement of road safety issues.

6.6 Privacy recommendations

Recommendation 33: Jurisdictions operating point-to-point speed enforcement systems should conduct Privacy Impact Assessments (PIA) to assess the privacy impacts of their systems. This assessment should form part of a Privacy Management Plan that includes privacy protections and complaint handling mechanisms for point-to-point speed enforcement systems and is reviewed regularly to ensure appropriate use of collected data.

A PIA can be updated as a project progresses and more information on the design and functioning becomes available. Any proposed use of data for purposes other than speed enforcement should be the subject of a PIA to ensure the correct balance is achieved between individuals' right to privacy and the public interest in maintaining the safety and security of the community.

Such privacy issues to be addressed in the PIA may include: protection of individual identity of vehicle occupants in association with camera images; capturing data relating to non-offending vehicles/motorists; data storage, retrieval, archiving and destruction protocols; data security, access control and access logs; and audit requirements for system security and privacy management. While this may be particularly useful for jurisdictions that are yet to proceed with point-to-point systems, it is also seen as helpful for those currently operating such systems in order to identify risks or benefits of information handling practices.

The PIA should ideally form part of an overall Privacy Management Plan that is reviewed regularly to ensure appropriate use of all collected data. The plan should include (among other things): a provision that imposes an obligation on road transport or law enforcement authorities within each jurisdiction to make individuals aware of how their personal information may be collected, used and disclosed; be predicated around collecting only the minimum amount of personal information necessary and have measures in place to ensure all information is kept accurate, complete and up to date; outline that information collected from the system should only occur if it is related to the specific purpose for which the system was implemented and that data aggregation or linkage should occur only in limited circumstances and within strict guidelines; set out minimum security measures that should be adopted to protect personal information; give individuals the opportunity to access and correct (if necessary) information pertaining to them and complain if they are concerned about the way in which their personal information is handled; and, contain a provision which provides for the destruction of data that is no longer required.

The Privacy Management Plan could be legislated or enacted at a policy/administrative level. The plan could be guided by the ‘4A Framework’ that was developed by the OAIC to assist government agencies to balance competing priorities in regard to data usage. In addition, a best practice guide could be developed to provide guidance to jurisdictional road transport and law enforcement agencies on how PIAs can be conducted and how Privacy Management Plans could be implemented.

Recommendation 34: The prescribed functions of the point-to-point system should be clearly identified. Any aspirations for extending the functionality of the system should only occur if there is no negative impact on the primary function of the system to monitor average vehicle speeds.

To enhance the integrity of point-to-point systems, it is recommended that the prescribed functions of the system be clearly identified. The decision regarding whether the function/s are outlined in legislation or represent policy recommendations should rest with each jurisdiction. It is also recommended that extensions of the functionality of the system must not negatively impact upon the primary function of point-to-point systems to monitor average vehicle speeds. That said, given the expensiveness of the technology to develop and install, but the limited additional costs associated with having the systems serve a number of functions, it is encouraged that other concurrent uses for the technology be explored. Other functions of the system might include: unregistered vehicle and unlicensed driver checks, criminal database checks, counter-terrorism purposes or collection of data relating to journey-time travel information.

6.7 Additional suggestions

In addition to the recommendations for better practice outlined above, a number of suggestions are also made. These reflect instances where recommendations may be unnecessarily restrictive.

Firstly, it is suggested that jurisdictional government organisations should primarily maintain responsibility for the operation and management of point-to-point speed enforcement systems. This suggestion acknowledges that such an approach may assist in facilitating greater transparency and integrity in the systems and reduce motorist suggestions that the enforcement method is primarily associated with revenue-raising. This is perceived to be particularly important in relation to the administration of infringement notices. Public perceptions and attitudes toward the approach are argued to be important given that the approach is relatively new and that the motoring public may have difficulty understanding how the technology operates.

Secondly, consideration should be given to wholly or partly hypothecating the revenue from point-to-point speed enforcement systems into road safety and/or other public health projects and initiatives. This is currently the case with other speed camera revenue in Queensland and partly in Western Australia (currently one third increasing to 100% by 2012/13). Such a practice, particularly if well communicated to the public, would be likely to further appease criticisms that speed camera operations are performed primarily for the purpose of increasing consolidated revenue. Such a suggestion is also relevant to the revenue generated from other speed enforcement approaches.

Thirdly, national licence and registration databases (such as NEVDIS) must ensure adequate ability for cross-jurisdictional cooperation, including the sharing of information to improve prosecutability of interstate offenders.

6.8 Implications of findings for the Austroads Guide to Road Safety

The findings of the current research have limited direct implications for the Austroads Guide to Road Safety. In regards to safety for rural and remote areas (Part 5), the findings of the current report suggest that the use of point-to-point speed enforcement systems on rural roads (in addition to urban roads) should be more thoroughly investigated and evaluated. Indeed, the Guide suggests that ‘rural enforcement programs need to utilise randomised scheduling or deployment methods to enable low levels of police presence to achieve more widespread coverage of vast road networks’ (Tziotis, Roper, Edmonston, & Sheehan, 2006; p. 35). Given the more network-wide effects associated with point-to-point enforcement and the capability to enforce longer sections of road, the approach represents a particularly potentially effective countermeasure. Indeed, the New South Wales Auditor General’s report (Auditor-General New South Wales, 2011b) into young driver safety recommended the use of point-to-point speed enforcement in rural areas.

REFERENCES

A77 Safety Group. (2007). Casualties halved on A77 - SPECS: End of 2nd year casualty statistics. News Realease, 26 October, 2007. Strathclyde, Scotland. Retrieved from http://www.a77safetygroup.com/index.cfm/page/31/newsitem/31/newscategory/0/%3Cbr%20/%3E

A77 Safety Group. (2008). SPECS continues to reduce A77 casualties: 3-year results. News Realease, October, 2008. Strathclyde, Scotland. Retrieved from http://www.a77safetygroup.com/index.cfm/page/31/newsitem/35/newscategory/0/

Aarts, L., & van Schagen, I. (2006). Driving speed and the risk of road crashes: A review. *Accident Analysis & Prevention, 38*(2), 215-224.

Auditor-General New South Wales. (2011a). *Improving Road Safety: Speed Cameras, Road and Traffic Authority - New South Wales Auditor-General's Report*. Sydney: Auditor-General New South Wales.

Auditor-General New South Wales. (2011b). *Improving Road Safety: Young Drivers. Road and Traffic Authority - New South Wales Auditor-General's Performance Audit*. Sydney: Auditor-General New South Wales.

Australian Transport Council. (2011). *National Road Safety Strategy 2011-2020*. Canberra: Australian Transport Council.

Austroads (2006). *Guide to Road Safety. Part 5: Road Safety for Rural and Remote Areas*. Sydney: Austroads.

Autostrade per l'Italia. (2009). Section control in Italy (Translated). Retrieved February 9 2009, from http://www.autostrade.it/assistenza-al-traffico/tutor.html?initPosAra=3_4

Barker, R. (2005). Got your number! *Surveyor, 12 May*, 14-16.

Benz, S., & Oehry, B. (2003). *Systems for automatic traffic enforcement using digital cameras*. Paper presented at the 10th World Congress and Exhibition on Intelligent Transport Systems and Services, Madrid.

Bureau of Transport Economics. (2000). *Road Crash Costs in Australia. BTE Report 102*. Canberra: Bureau of Transport Economics.

Cameron, M. H. (2008). *Development of Strategies for Best Practice in Speed Enforcement in Western Australia. Supplementary Report.* Melbourne: Monash University Accident Research Centre.

Cascetta, E., & Punzo, V. (2011). *Impact on vehicle speeds and pollutant emissions of an automated section speed enforcement system on the Naples urban motorway*. Paper presented at the TRB 2011 Annual Meeting.

Cascetta, E., Punzo, V., & Montanino, M. (2011). *Empirical evidence of speed management effects on traffic flow at freeway bottleneck*. Paper presented at the TRB 2011 Annual Meeting.

Champness, P., Sheehan, M., & Folkman, L.-M. (2005). *Time and distance halo effects of an overtly deployed mobile speed camera.* Paper presented at the Australasian Road Safety Research, Policing and Education Conference, Wellington, New Zealand.

Charlesworth, K. (2008). *The effect of average speed enforcement on driver behaviour*. Paper presented at the Road Transport Information and Control - RTIC and ITS United Kingdom Members' Conference, Manchester.

Christie, S. M., Lyons, R. A., Dunstan, F. D., & Jones, S. J. (2003). Are mobile speed cameras effective? A controlled before and after study. *Injury Prevention, 9*, 302-306.

Cirillo, J. A. (1968). Interstate system crash research; study II, interim report II. *Public Roads, 35*(3), 71-76.

Collins, G. (2007a). Smarter than the average. *ITS International*, 48-49.

Collins, G. (2007b). *Traffic flow improvements with average speed enforcement*. Paper presented at the International Conference on Intelligent Transport Systems, Birmingham, United Kingdom.

Collins, G. (2010). *A14 Route Enforcement Scheme: A Case Study in Effective Average Speed Control*. London: Speed Check Services.

Collins, G., & McConnell, D. (2008). Speed harmonisation with average speed enforcement. *Traffic Engineering and Control, 49*(1), 6-9.

Connelly, L. B., & Supangan, R. (2006). The economic costs of road traffic crashes: Australia, states and terrirtories. *Accident Analysis & Prevention, 38*, 1087-1093.

Crawford, E. (2009). *Beyond 2010 - A Holistic Approach to Road Safety in Great Britain*. London: Parliamentary Advisory Council for Transport Safety.

Dalbert, T. (2001). Speed cameras slash road deaths: New digital technology is having a significant deterrent effect. *ITS International, 7*(3), 58.

Elliott, M., & Broughton, J. (2005). *How Methods and Levels of Policing Affect Road Casualty Rates*. TRL Report TRL637, London: TRL.

Fleiter, J., & Watson, B. (2006). *The speed paradox: the misalignment between driver attitudes and speeding behaviour.* Paper presented at the Australasian Road Safety Research, Policing and Education Conference

Freeman, J. E., & Watson, B. (2006). An application of Stafford and Warr's reconceptualization of deterrence to a group of recidivist drink drivers. *Accident Analysis & Prevention, 38*(3), 462-471.

Gains, A., Humble, R., Heydecker, B., & Robertson, S. (2003). *A cost recovery system for speed and red-light cameras – two year pilot evaluation, 2003. Research Paper*. London, England: Department for Transport, Road Safety Division.

Gains, A., Nordstrom, M., Heydecker, B., Shrewsbury, J., Mountain, L., & Maher, M. (2005). *The National Safety Camera Programme: Four-Year Evaluation Report*. London: PA Consulting Group.

Galata, A. (2007). *La Prevenzione Nella Sicurezza Stradale: Risultati Tutor Primi 12 Mesi (Results of 'Tutor' After 12 Months)*. Italy: Autostrade per I'italia.

Gil, M. J. M., & Malenstein, J. (2007). *Deliverable 1: Innovative Technology for Monitoring Traffic, Vehicles and Drivers*: Police Enforcement Policy and Programmes on European Roads.

Glendon, A. I. (2007). Driving violations observed: An Australian study. *Ergonomics, 50*(8), 1159-1182.

Glendon, A. I., & Sutton, D. C. (2005). Obsevring motorway driving violations. In D. A. Hennessy & D. L. Wiesenthal (Eds.), *Contemporary Issues in Road User Behavior and Traffic Safety*. New York: Nova Science Publishers.

Grunnan, T., Vaa, T., Ulleberg, P., Malenstein, J., Zaidel, D., Kauvo, K., et al. (2008). *Implications of Innovative Technology for the Key Areas in Traffic Safety: Speed, Drink Driving and Restraint Systems*. Europe: Police Enforcement Policy and Programmes on European Roads.

Hatfield, J., & Job, R. F. S. (2006). *Beliefs and Attitudes about Speeding and its Countermeasures*. Canberra: Australian Transport Safety Bureau.

Hess, S., & Polak, J. (2004). Analysis of the effects of speed limit enforcement cameras: Differentiation by road type and catchment area *Transportation Research Record, 1865*, 25-33.

Highways Agency, & Consultants, A. (2009). *LNMS Evaluation Report. A14 Huntingdon to Cambridge Safety Cameras*. London: Highway Agency.

Kallberg, V. P., Zaidel, D., Vaa, T., Malenstein, J., Siren, A., & Gaitanidou, E. (2008). *Final Report of project PEPPER. PEPPER Deliverable 17*: Police Enforcement Policy and Programmes on European Roads.

Keenan, D. (2002). Speed cameras: The true effect on behaviour. *Traffic Engineering and Control, 43*, 154-160.

Kloeden, C. N., McLean, A. J., & Glonek, G. (2002). *Reanalysis of Travelling Speed and the Risk of Crash Involvement in Adelaide South Australia*. Canberra: Department of Transport and Regional Services, Australian Transport Safety Bureau.

Kloeden, C. N., McLean, A. J., Moore, V. M., & Ponte, G. (1997). *Travelling Speed and the Risk of Crash Involvement: Volume 1 - Findings*. Adelaide: NHMRC Road Accident Research Unit, The University of Adelaide.

Koy, T., & Benz, S. (2009). *Automatic time-over-distance speed checks impacts on driving behaviour and traffic safety*. Paper presented at the 6th ITS World Congress and Exhibition on Intelligent Transport Systems and Services, Stockholm.

Kuratorium fur Verkehrssicherheit. (2007). *Summary and Publication of Best Practices in Road Safety in the Member States. Thematic Report: Enforcement*. Austria: European Commission.

Kursius, A., King, T., & Russo, L. (2003). *The benefits of a digital platform for enforcement and compliance* Paper presented at the 10th World Congress on Intelligent Transport Systems and Services, Madrid, Spain

Lee, S. (2007). Study on the Introduction of Speed Enforcement System Using Point-to-point Speed Measurement. *Not in English*.

Lynch, M. (2010). *Forward Design Study: Introduction of Point to Point Speed Cameras in the ACT*. Canberra: AECOM Australia.

Malenstein, J. (1997). *Automated Video Speed Enforcement and Trajectory Control Combined with Fully Automated Processing*. Driebergen, Netherlands: Dutch National Police Agency, Traffic and Transport Division

Nilsson, G. (2004). *Traffic Safety Dimensions and the Power Model to Describe the Effect of Speed on Safety. Bulletin 221.* Lund: Lund Institute of Technology.

Organisation for Economic Co-Operation and Development. (2006). *Speed Management*. Paris, France: Organisation for Economic Co-Operation and Development.

Orozova-Bekkevold, I., Martinez, M., & Akkermans, L. (2007). *Needs and Objectives of the EC Regarding TLE Data in the Light of Data Availability and the Technical Aspects of Data Collection and Exchange: Working Paper 12*: Police Enforcement Policy and Programmes on European Roads.

Palmer, T. (1999). Digital deterrent. *Highways, 68*(6), 20-21.

Parliamentary Travelsafe Committee. (2008). *Report on the Inquiry into Automatic Number Plate Recognition Technology. Report No. 51*. Brisbane: Parliamentary Travelsafe Committee.

Peden, M., Scurfield, R., Sleet, D., Mohan, D., Hyder, A. A., Jarawan, E., et al. (Eds.). (2004). *World Report on Road Traffic Injury Prevention*. Geneva: World Health Organization.

Punzo, V., & Cascetta, E. (2010). *Impact on vehicle speeds and pollutant emissions of the fully automated section speed control scheme 'Safety Tutor' on the Naples urban motorway*. Paper presented at the SIDT - Scientific Seminar - External costs of transport systems: theory and applications, Rome.

Redflex Traffic Systems. (2007). *Redflex Point-to-Point Technical Overview*: European Factsheet.

Richter, E. D., Berman, T., Friedman, L., & Ben-David, G. (2006). Speed, road injury and public health. *Annual Review of Public Health, 27*, 125-152.

Rijkswaterstaat Directie-Zuid-Holland. (2003). *Evaluatie 80 km/uur-Maatregel A 13 Overschie: Doorstroming en Verkeersveiligheid*. Rotterdam, Netherlands: Rijkswaterstaat Directie Zuid-Holland.

Roads and Traffic Authority. (2000). *Speed Problem Definition and Countermeasure Summary*. New South Wales: Roads and Traffic Authority.

Roads and Traffic Authority. (2010). *Point-to-Point Speed Enforcement for Heavy Vehicles: Fact Sheet*. Sydney: Roads and Traffic Authority.

Robinson, D., & Singh, R. (2006). Contributory factors to road accidents *Road Casulaties: Great Britain 2006*. London: Department for Transport.

Schwab, N. (2006). *For a better safety and traffic flow optimisation during peak periods: Speed control experimentation on the A7 motorway*. France: Autoroutes du Sud de la France.

Scottish Safety Camera Programme. (2006). Safety cameras on A77 showing positive effects in first year. News Realease, 2006. Scotland. Retrieved from http://www.scottishsafetycameras.com/A77-first-year.aspx

Simcic, G., & Townsend, E. (2008). *Managing Speed: Towards Safe and Sustainable Road Transport*. Brussels, Belgium: ETSC.

Solomon, D. (1964). *Crashes on Main Rural Highways Related to Speed, Driver and Vehicle*. Washington, D.C.: Bureau of Public Roads. U.S. Department of Commerce

Speed Check Services. (2004). *Temporary Speed Deterrent System - France*. London: Speed Check Services.

Speed Check Services. (2006). *Temporary Roadworks Speed Enforcement - M1 Jn 20-21*. London: Speed Check Services.

Speed Check Services. (2007a). *Bridge Enforcement - Tower Bridge, London*. London: Speed Check Services.

Speed Check Services. (2007b). *Temporary Roadworks Speed Enforcement - M6 Jn 12-13*. London: Speed Check Services.

Speed Check Services. (2008a). *M1 6a-10 Motorway Widening Scheme*. London: Speed Check Services.

Speed Check Services. (2008b). *M4 Jn 10-12 NMIS Scheme: An analysis of driver behaviour, speed distributions/profiles and collisions within the SPECS enforced roadworks*. London: Speed Check Services.

Speed Check Services. (2009a). *SPECS Safety Cameras – M4 10-12 Technology Upgrade*. London: Speed Check Services.

Speed Check Services. (2009b). SPECS: Results. Retrieved February 9 2009, from http://www.speedcheck.co.uk/specs.htm

Speed Check Services. (2010). *Avergae Speed Enforcement Solutions: Safer, Smoother, Greener, Fairer*. London: Speed Check Services.

Stafford, M. C., & Warr, M. (1993). A reconceptualization of general and specific deterrence. *Journal of Research in Crime & Delinquency, 30*(2), 123-135.

Stefan, C. (2005). *Automatic Speed Enforcement on the A13 Motorway (NL): Rosebud WP4 - Case B Report*. Austria: Austrian Road Safety Board (KfV).

Stefan, C. (2006). *Section Control - Automatic Speed Enforcement in the Kaisermuhlen Tunnel (Vienna, A22 Motorway)*. Austria: Kuratorium fur Verkehrssicherheit.

Stephens, P. (2007). *Scheme 255: M5 Junctions 29 – 30, Exeter Speed Management*. London: Highways Agency.

Stevens, P. (2007). *Scheme 255: M5 Junctions 29 – 30, Exeter Speed Management*. London: Highways Agency.

Stoelhorst, H. (2008). *Reduced speed limits for local air quality and traffic efficiency*. Paper presented at the 7th European Congress and Exhibition on Intelligent Transport Systems and Services, Geneva, Switzerland.

SWOV Institute for Road Safety Research. *SWOV Fact sheet - Police Enforcement and Driving Speed*.

Taylor, M. C., Lynam, D. A., & Baruya, A. (2000). *The Effects of Drivers' Speed on the Frequency of Road Accidents. TRL Report, No. 421.* Crowthorne, Berkshire: Transport Research Laboratory.

Thornton, T. (2010). *Reductions in fuel consumption and CO2 emissions with specs average speed enforcement*. Paper presented at the Road Transport Information and Control Conference and the ITS United Kingdom Members' Conference - Better transport through technology, London.

Townsend, E. (2006). *Enforcement Monitor (No. 6)*. Brussels, Belguim: ETSC.

Townsend, E., & Achterberg, F. (2005). *Enforcement Monitor (No. 4)*. Brussels, Belguim: ETSC.

Transport Scotland. (2009). Average speed cameras. Retrieved 9 February, 2009, from http://www.transportscotland.gov.uk/road/average-speed-cameras

Transportation Research Board. (1998). *Managing Speed: Review of Current Practice for Setting and Enforcing Speed Limits*. Washington, D.C.: National Academy Press.

Vaa, T. (1997). Increased police enforcement: effects on speed. *Accident Analysis and Prevention, 29*(373-385).

van Schagen, I. N. L. G., Wegman, F. C. M., & Roszbach, R. (2004). *Veilige en Geloofwaardige Snelheidslimieten: Een Strategische Verkenning* Leidschendam, Netherlands: SWOV.

Victorian Auditor-General's Office. (2011). *Victorian Auditor-General's Report: Road Safety Camera Program*. Melbourne: Victorian Auditor-General's Office.

Walker, E., Bryant, P., Barnes, B., Johnson, B., & Murdoch, C. (2009). *Quantitative study of attitudes, motivations and beliefs related to speeding and speed enforcement*. Paper presented at the Australasian Road Safety Research, Policing and Education Conference, Sydney, Australia.

Walker, E., Murdoch, C., Bryant, P., Barnes, B., & Johnson, B. (2009). *Quantitative study of attitudes, motivations and beliefs related to speeding and speed enforcement*. Paper presented at the Australasian Road Safety Research, Policing and Education Conference, Sydney, New South Wales.

Wegman, F., & Goldenbeld, C. (2006). *Speed Management: Enforcement and New Technologies*. Leidschendam, Netherlands: SWOV Institute for Road Safety Research.

Wiggins, A. (2006). *ANPR technology and applications in ITS*. Paper presented at the 22nd ARRB Conference, Canberra, ACT, Australia.

Wilson, C., Willis, C., Hendrikz, J. K., Le Brocque, R., & Bellamy, N. (2010). Speed Cameras for the Prevention of Road Traffic Injuries and Deaths. *Cochrane Database of Systematic Review*(Issue 11).

Young, K. L., & Regan, M. A. (2007). *Intelligent Transport Systems to Support Police Enforcement of Road Safety Laws*. Canberra: Australian Transport Safety Bureau.

Appendix A. LIST OF SEARCH TERMS USED AND DATABASES SEARCHED

These search terms were used in an iterative approach, combining terms when necessary to yield more relevant results.

- Point-to-point
- Average speed enforcement
- Average speed cameras
- Section control
- Trajectory control
- SPECS
- Tutor
- Time-over-distance
- Speed-over-distance
- Distance-over-time
- Speed enforcement
- Speed camera
- Safety camera
- Automatic number plate recognition (ANPR)
- Automatic licence plate recognition (ALPR).

The following databases were searched:

- ScienceDirect
- PyschInfo
- Australian Transport Index
- Webspirs
- Transportation Research Information Database
- Transport Database (via OvidSP).

In addition:

- Google and Google Scholar searches were performed
- Websites for key road safety organisations, police and transport authorities and speed camera technology manufacturers were searched.

Appendix B. INTERVIEW SCHEDULE

This interview schedule was slightly altered dependent on the jurisdiction being consulted, such that references to the approach were based on the most popular terminology for that jurisdiction (e.g., Australia – point-to point; United Kingdom – average speed enforcement; Italy – Tutor; other parts of Europe – section or trajectory control).

POINT-TO-POINT QUESTIONNAIRE

This questionnaire has been developed as part of a collaborative project being conducted in Australia by The Centre of Accident Research and Road Safety – Queensland (CARRS-Q) in conjunction with Austroads to investigate best practice in the use of point-to-point speed enforcement, also commonly referred to as average speed enforcement or section control. The outcome of this research will be recommendations for the implementation of point-to-point enforcement in Australia and New Zealand.

This questionnaire is intended to elicit a general overview of the extent of point-to-point implementation in your jurisdiction and the technological and site selection characteristics of the systems employed. In addition, operational, legislative and broader speed management issues are also covered.

This questionnaire includes the following sections:

1. Extent of the use of the point-to-point
2. Site selection issues
3. Technological characteristics
4. Operational policy and practice and system management issues
5. Legislative issues
6. Broader speed management issues
7. Public education
8. Evaluation

Instructions for answering the questionnaire:

Please ensure that you answer the questions as they relate to <u>your</u> jurisdiction. The questionnaire can be answered and returned electronically or via post. Where needed, please increase the space necessary to provide a response.

[CONTACT DETAILS OMITTED FROM THIS REPORT]

1. Extent of the use of the technology

1. Has point-to-point speed enforcement ever been trialled or used in your jurisdiction?

☐ Yes. Currently used/trialled (*Please continue to Q2*)

☐ Yes. Previously used/trialled, but not current (*Please continue to Q3*)

2. How many point-to-point systems are **<u>currently</u>** employed in trial form, how many are temporary/mobile systems and how many are fixed/permanent systems (*Please write the number of systems that corresponds to the type*)?

____ Trial site (Temporary/mobile)

____ Trial site (Fixed/permanent)

____ Temporary/mobile systems

____ Fixed permanent systems

3. How many point-to-point systems were **<u>previously</u>** used, but are no longer currently being used (*Please write the number of systems that corresponds to the type*)?

____ Trial site (Temporary/mobile)

____ Trial site (Fixed/permanent)

____ Temporary/mobile systems

____ Fixed permanent systems

4. Please provide a list of the location (e.g., X44 Motorway between Junctions 1 and 2) of all the point-to-point systems currently used in your jurisdiction (please attach as a separate document if insufficient space).

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________
6. ____________________
7. ____________________
8. ____________________
9. ____________________
10. ____________________

PLEASE ANSWER THE FOLLOWING QUESTIONS IN RELATION TO **<u>CURRENT IMPLEMENTATIONS OF POINT-TO-POINT</u>** SPEED ENFORCEMENT IN YOUR JURISDICTION.

Note: in jurisdictions where too many systems are operating to list all information, please give a mean, range or some other form of aggregated response.

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2. Site selection issues

5. What criteria are used for choosing locations where systems are implemented (e.g., crash history, speeding problems, traffic flow issues, emission concerns, benefit/cost ratio, etc)?
6. How long are the stretches of road that are enforced? Please ensure to also provide distance between camera sites if system involves multiple sites. Note: if too many systems are operating to list all distances, please give a mean and range.
7. Are there opportunities for access and egress throughout the enforcement corridor?
8. Is there only one speed limit throughout the enforced section of road or do speed limits vary? Are Variable Message Signs (VMS) used to display current speed limits?
9. What are the parameters used for determining the distances between camera sites, if any (e.g., minimum and maximum distances, etc)?

3. Technological issues

Cameras & Illumination

1. How many cameras are operated within each system?
2. How many camera sites are involved in each system?
3. What resolution are the cameras?
4. Are the cameras digital or analogue?
5. Are the cameras monochrome or colour?
6. How are the cameras activated (e.g., continual video-streaming, laser/radar, induction loops, etc)?
7. Are the cameras forward-facing, rearward facing or are both used?
8. Is there a designated camera for each lane or do cameras monitor multiple lanes?
9. What type of illumination method is used (e.g., continuous illumination, triggered illumination, infrared illumination, etc)?

Infrastructure

10. For fixed/permanent systems, how are the cameras mounted (e.g., side-mounted, installed overhead, combination approach using roadside cantilevers, etc)?
11. What infrastructure is used (e.g., poles, overpass, gantry, etc) and did it exist before the point to point system was introduced or was it purpose built?
12. For mobile/temporary systems, how are the cameras mounted (e.g., vehicle, trailer, temporary pole, etc)?
13. How are the cameras housed/enclosed? Does the housing provide protection from various weather conditions or anticipated tampering or vandalism?
14. Have there been any issues associated with vandalism or tampering with the equipment?
15. What power source does the system use (e.g., AC, DC, other)?

System software and local server

16. What types of software are used (e.g., Automatic Number Plate Recognition (ANPR), Optical Character Recognition (OCR), etc)?

17. What approach is used by ANPR engine to match images (e.g., template matching, structural analysis, neural networks, etc)?
18. Is the ANPR engine located at the roadside (e.g., embedded processor) or in the back-office?
19. What hardware is used to operate the system (e.g., small industrial PC, laptop, etc)?
20. What size and file type of image data is produced by the system?
21. What, if any, other data is captured by system (e.g., vehicle type, lane position, etc)?
22. How and where is the data collected by the system stored? What protocols are in place to ensure the security and privacy of this data?

Communications network & back office processing

23. What technology is used for the communications network (e.g., fibre optic cables, wireless technologies (e.g., WiFi, GSM, GPRS, CDMA or 3G, Ethernet, etc)?
24. What data is sent through the communication network to the back-office?
25. What information is included in the data block for enforcement purposes (e.g., speed limit, capture speed, lane information, date and time, location, image, operator details, etc)?
26. How automated is the back-office (e.g., what degree of manual checking occurs)?

4. Operational policy and practice and system management issues

1. Are there mandatory maintenance schedules for the system? If so, what are the conditions of these schedules and how often are they conducted?
2. What technology is used to synchronise the time on the cameras in the system (e.g., GPS)? What protocols are in place to safeguard against malfunctions when synchronisation is not achieved (e.g., auditing, maintenance checks)?
3. What methods were used to verify and certify the surveyed distance between camera sites?
4. Can the system reliably and accurately read dirty, damaged or unfamiliar (e.g., from another jurisdiction) vehicle license plates?
5. Is the system operated by the jurisdictional government or outsourced to a private company? What department/organisation/agency in particular is responsible for various aspects of the system (e.g., management of the system, databases and administration of infringement notices)?
6. What, if any, links are made from data collected by the system to other databases (e.g., licence registration or criminal databases)?

5. Legislative issues

1. What initial approval and certification procedures are involved with implementing a system?
2. For enforcement purposes, is identification of the driver (e.g., photographic) a necessity or is the onus of responsibility on the vehicle owner?
3. For systems with multiple camera sites or spot-speed enforcement at the camera sites, is there a multiple infringement policy? If so, please provide details such as what offence is given priority?
4. Does the system operate with an enforcement tolerance? If yes, is this tolerance threshold different to other automated speed enforcement approaches in your jurisdiction? Please give examples where possible.
5. What are the legislative requirements for signage, both prior to and during the enforcement corridor (e.g., how many signs, placement and proximity relative to cameras, wording/graphical display on signs)?

6. Were there any legislative changes necessary before average speed enforcement systems could be introduced in your jurisdiction (e.g., development of an average speed offence, etc)? If yes, please describe them.
7. Were there any privacy issues/considerations associated with the introduction of average speed enforcement systems in your jurisdiction (e.g., identification of drivers and matching of license plate information with other data bases)? If so, please provide as much detail as possible regarding what the issues were and how they were dealt with.

6. Broader speed management issues

1. What other approaches are currently used (automated or otherwise) to enforcement speed limits in your jurisdiction?
2. What role does point-to-point speed enforcement play in the overall speed management strategy (e.g., what proportion of speed enforcement efforts are represented by point-to-point speed camera operation)? How is this role likely to change in coming years?
3. From your experience, what are the perceived advantages associated with point-to-point speed enforcement as a speed management tool?
4. From your experience, what are the perceived disadvantages associated with point-to-point speed enforcement as a speed management tool?

7. Public education

1. What steps, if any, were/will be taken to educate the public regarding the introduction of point-to-point speed enforcement?
2. From your experience, how important do you believe it is to inform the public about point-to-point speed enforcement before implementing it?
3. From your experience, can you describe the benefits of educating the public about the use of P2P speed enforcement (e.g., its influence on perceived legitimacy and acceptance)?

8. Evaluation

1. For existing point-to-point speed enforcement systems, have any evaluations been conducted (e.g., process evaluation, outcome evaluation, cost-effectiveness analysis, technological feasibility study, level of driver acceptance)?
2. For impending point-to-point speed enforcement systems, are there plans to conduct any evaluations (e.g., process, outcome, cost-effectiveness, technological feasibility, driver acceptance)?

Additional comments

Please feel free to use this space to provide any additional comments you believe may be pertinent to the research.

Appendix C. ADDITIONAL STAKEHOLDER CONSULTATION FINDINGS

In addition to the stakeholder organisations discussed in Section 5 of this report, a number of additional organisations were consulted, including motoring groups and relevant national agencies. The findings in relation to these organisations are outlined below. Specifically, the additional organisations consulted included:

- Royal Automobile Club of Queensland (RACQ) – Queensland
- Royal Automobile Club of Victoria (RACV) – Victoria
- Royal Automobile Club of Tasmania (RACT) – Tasmania
- National Roads and Motorists Association (NRMA) – New South Wales & the ACT
- Royal Automobile Association (RAA) – South Australia
- Royal Automobile Association (RAA) – Western Australia
- Motorcycle Council of New South Wales (MCC) – New South Wales
- Australian Trucking Association (ATA) – National
- National Measurement Institute (NMI) – National
- The Office of the Australian Information Commissioner (OAIC) – National.

Royal Automobile Club of Queensland (RACQ)

The RACQ argued that point-to-point speed enforcement was only acceptable for sections of road of a minimum two kilometres in distance, suggesting that distances shorter than this could be appropriately enforced using fixed camera approaches. However, the stakeholder did note that they would support the use of point-to-point in areas where the implementation of other speed enforcement approaches was not feasible or safe. It was argued that the use of the approach is best suited for sections of road with a crash history and that sections of road enforced should have a consistent speed limit.

Overall, RACQ perceived mobile police patrols as the most effective approach to speed enforcement, given the increased immediacy of punishment and the ability to address other dangerous and illegal behaviours also. However, the importance of automated approaches was also stressed. Further, it was argued that other traffic enforcement operations within the point-to-point enforcement corridor must be carefully considered. Specifically, they supported the use of mobile police patrols monitoring other illegal and dangerous behaviours, however did not support the use of other automated speed enforcement approaches (e.g., mobile speed camera operation) within the corridor.

The RACQ suggested that the most important factor regarding maintenance schedules was to ensure that the level of legitimacy associated with current speed enforcement devices in Queensland was maintained. Concerns were expressed regarding the potential for vandalism and maintenance of more rural and remote systems. It was stressed that the government (e.g., Police and transport authority) should be responsible for the operation and management of the system, including the administration of infringements.

While the RACQ supported the use of data collected from point-to-point systems to identify unregistered and uninsured vehicles, they expressed concerns regarding the immediacy of such infringements. A preference was expressed regarding the application of an identical enforcement tolerance as used with other automated speed detection devices in the state. In regard to signage, there was a preference for overt operation, with signs both prior to and within the enforcement corridor. Moreover, while there were suggestions that signage should include an indication of the length of the enforcement corridor, the implications of the system having the capability to measure both instantaneous and average speeds were noted. The RACQ also expressed support for the use of mobile ANPR systems.

Finally, the RACQ stressed the importance of public education, and argued that education should highlight how point-to-point speed enforcement fits into the overall speed management strategy in the state, as well as an explanation of why the technology is being used, how it works and why the particular site was chosen as an enforcement location.

Royal Automobile Club of Victoria (RACV)

The RACV perceives point-to-point speed enforcement to be most effectively implemented on high volume roads with high levels of low-level speeding. The use of the approach is not strongly supported in crash black-spots, based on an uncertainty of the technology to affect behaviour in such instances and a suggestion that fixed speed cameras are a more appropriate alternative.

It was argued that the fundamental requirement of mandatory maintenance schedules must be to ensure the technology is robust and reliable. A preference was expressed for jurisdictional government to be responsible for the management and operation of point-to-point systems, or at least accountable. It was suggested that the Victorian public are generally unaware of the governance context of point-to-point operations, assuming that the police are responsible for the operation of the system.

It was noted that enforcement tolerances are not publicly disclosed in Victoria, with non-disclosure primarily aimed at preventing the creation of a de facto speed limit amongst drivers. It was commented that if enforcement tolerances are set too low, issues with the relative risk of driving at such speeds arise, however if tolerances are set too high the road safety benefits of enforcement are lost.

In addition, there was a suggestion of needing to protect against ‘function creep’, a situation by which the system is used to enforce other offences, or for any other purposes other than speed enforcement. It was argued that the Victorian public would not be very likely support such additional uses of the technology without prior transparent and open discussions of such intentions.

There was some suggestion that the public of Victoria are typically disbelieving of the link between excessive speed and increased vehicle emissions. It was noted that while the Victorian Government has made concerted efforts to communicate to the driving public the importance of speed cameras, a number of high-profile cases (e.g., the incorrect issuing of nine infringements in relation to the Hume Highway system) has left many drivers sceptical of the accuracy and reliability of point-to-point cameras and speed cameras in general.

Royal Automobile Club of Tasmania (RACT)

The RACT expressed support for the implementation of point-to-point speed camera systems for use on sections of road with histories of crashes and speeding problems. It was argued that the approach would be particularly beneficial if implemented on rural roads where a culture of speeding exists. The use of the technology was not supported for lower speed limit roads however. It was noted that the length of enforcement corridors must be carefully considered to ensure limited opportunities for access and egress and that deterrent impacts are not diminished due to the length of the site.

The RACT reported a preference for the management and operation of systems to be the responsibility of the jurisdictional government, due to problems experienced in other states and to increase the transparency and accountability of enforcement operations. However, it was noted that the RACT would support the management of the system to be outsourced, with the exception that government agencies are responsible for infringement adjudication and administration. It was suggested that maintenance schedules should be conducted, at minimum, according to manufacturer specifications, by appropriately qualified technicians.

There was a belief that the systems needed to be overtly operated, with signage to occur both prior to and within the enforcement corridor and relate specifically to average speed checks. An enforcement tolerance was argued to be critical to the overall fairness of the system, with the RACT expressing a preference that the tolerance for point-to-point systems should align with other automated speed enforcement approaches. It was suggested that an argument for reducing the tolerance would be hard to ‘sell’ to the public, with issues arising in relation to the relative crash risks associated with such speeds.

The RACT also supported the use of data collected from the system being linked with databases to check for unregistered vehicles, unlicensed drivers and outstanding warrants, suggesting that privacy would not be invaded unless an individual is an offender. It was noted that there would need to be careful consideration in explaining such a process to the public however. It was anticipated that a number of privacy issues (e.g., collection of data, particularly images, relating to non-offending individuals) would be raised by the public and privacy groups, however none were perceived to be insurmountable.

The RACT argued that point-to-point speed cameras must represent an additional tool for speed management rather than a replacement for existing approaches. The primary advantages of the approach were reported to be more network-wide reductions in vehicle speeds and the development of a new perception of speed enforcement. The primary disadvantages were argued to be the difficulties in communicating the technological characteristics of the system to the public and ensuring the integrity of the technology with an open and transparent process argued to be fundamental to the success of implementation of the technology. Public education was argued to be critical, with the focus being to reinforce the safety benefits of speed enforcement rather than issuing tickets.

National Roads and Motorists Association (NRMA Motoring and Services)

The NRMA reported that they, as an organisation, supported the current Labour and Liberal government positions that the use of point-to-point speed cameras should be restricted to heavy vehicles only, and not used to enforce speeds among passenger vehicles. This position was argued to be due to the high number of crashes in New South Wales involving (although not necessarily caused by) heavy vehicles.

The NRMA stressed that they supported an increase in the number of fixed and mobile speed cameras in the state, and so were not ‘anti-cameras’. Instead, it was argued that the introduction of cameras needs to be associated with where traffic fatalities and injuries are occurring and reducing road trauma. In addition, it was argued that there is a need to target resources most efficiently. Specifically, it was argued that a greater visible police presence enforcing all traffic infringements (e.g., not just speed as is the case with speed cameras) would be the optimal approach supported by NRMA.

It was acknowledged that point-to-point speed cameras enforce a much larger distance and modify behaviour for a longer period of time compared to fixed and mobile cameras which are typically susceptible to halo affects. As such, it was acknowledged that point-to-point systems were a potentially useful countermeasure at locations that represented ‘black lengths’, as opposed to black spots. Indeed, it was suggested that this rationale could be applied to the current location of systems on regional roads for enforcement of heavy vehicles. However, there was also the argument that little evidence suggested that a succession of fixed speed cameras at more targeted locations might also be an effective countermeasure approach.

Irrespective of the type of camera (e.g., fixed, mobile or point-to-point), the NRMA stated that locations for speed cameras should be restricted to sites where serious crashes or fatalities are a particular concern or where safety concerns preclude or restrict the use of other enforcement approaches. The NRMA also argued that operations should be controlled by the Police or similar body, suggesting that outsourcing increased perceptions that efforts were associated with revenue-raising. Interestingly, it was suggested that the involvement of the RMS (the government transport authority in the state) in camera operations produced scepticism amongst motorists regarding whether cameras were operated for road safety or revenue-raising purposes.

While no preferences were expressed regarding operational characteristics of point-to-point systems, the NRMA stated that they would expect stringent requirements to ensure the appropriate maintenance and calibration of systems.

Similar to signage associated with fixed speed cameras in New South Wales, the NRMA expressed a view that point-to-point speed cameras should also be preceded by three warning signs. In addition, they suggested that, depending on the length of the enforced section, repeater signs would be necessary within the enforcement corridor. They also suggested that the specific content of the signs should reflect whether the cameras are being used to enforce average speeds, instantaneous speeds or both.

The NRMA expressed concern regarding function creep in association with point-to-point speed camera systems (e.g., the use of collected data for purposes other than speed enforcement).

At a broader level, the NRMA claimed that they did not believe the RMS had managed to ‘sell’ to the community the concept of the dangers associated with speeding and the need for speed cameras, leading to cynicism among motorists. It was suggested that continued revenue at speed camera locations was evidence that speed cameras were not solving the problem of speeding behaviour and that other countermeasures were required and a re-evaluation of locations where speed cameras are needed. In addition, the NRMA supported greater hypothecation of infringement revenue from speed cameras to road safety programs.

The NRMA perceived the primary advantage of point-to-point speed enforcement to be the fact that some motorists believe that they represent a fairer approach to speed management, compared to instantaneous speed checks. Potential disadvantages included the costs-effectiveness of point-to-point systems.

Royal Automobile Association (RAA; South Australia)

The RAA argued that point-to-point speed enforcement systems are best suited to national highways with heavy commercial vehicle use. In addition, it was stated that the technology may prove useful on urban roads with a history of crashes.

It was highlighted that South Australia is currently only legislated to enforce heavy vehicles with point-to-point systems; however it was expressed that the RAA would support expanding the use of the technology to light vehicles if provided with evidence that the approach reduces vehicles speeds.

No preference was expressed regarding the frequency of maintenance schedules; however it was stressed that the appropriate legislation must be in place and that technological feasibility must be achieved to ensure legitimacy of the systems. In particular, it was argued that the ANPR technology and clock synchronisation processes must be accurate, with human checks of all infringements necessary. There was a preference for the systems to be operated and managed by the government, with SAPol responsible for the issuing of infringement notices. It was argued that outsourcing of these responsibilities to a private organisation could harm the perceived legitimacy of the systems. Finally, the use of data collected from the systems to link to other databases (e.g., licence/registration, criminal) was supported on the proviso that the government is responsible for such checks and that access to data is appropriately restricted.

In addition, preferences were expressed for enforced sections to involve roads with a constant speed limit, and for enforcement tolerances to be identical to those associated with other automated approaches to speed enforcement. While a mix of covert and overt approaches to speed enforcement was supported, it was argued that point-to-point enforcement should be operated in an overt fashion.

Given the high cost of the technology, the requirement to ensure the approach is employed appropriately and efficiently was highlighted. In addition, the need for greater cooperation between states, and indeed between stakeholders within South Australia, was expressed, such that more appropriate communication platforms are developed to allow efficient sharing of data. Overall, the use of point-to-point was perceived as important, but it was stressed that such an approach should be complementary to existing approaches to speed management employed in the state.

Royal Automobile Club of Western Australia (RAC; Western Australia)

The RAC-WA sits on the WA Road Safety Council as the representative of all road users. In addition, the RAC-WA is a signatory to the as yet non-funded Towards Zero Road Safety Strategy which calls for enhanced speed enforcement efforts, based on the MUARC report which recommended a mix of overt and covert cameras and point-to-point technology.

The RAC-WA expressed support for the introduction of point-to-point speed camera technology. It was reported that surveys of RAC-WA members have shown that the majority support the introduction of more speed cameras and new speed camera technology.

The RAC-WA believes that point-to-point speed cameras could play an important role in reducing the incidence of speeding on selected country routes and would allow for police resources to be better prioritised on other routes.

Motorcycle Council of New South Wales (MCC)

The MCC argued that research typically assumes that enforcement of average speeds reduces road trauma by reducing travel speeds and subsequently reducing impact speeds in the event of a crash. It is argued that while there is evidence to support such a premise for those road users who are encased and restrained in a vehicle such as a car or truck, there is little evidence to support this view when considering other road user groups such as pedestrians, bicyclists or motorcyclists, in which any crash involving another vehicle is likely to result in serious injury. The MCC suggested that such a perspective reflects the fact that motorcycles are generally considered as small cars when considering transport policy and legislation, road rules, and design criteria for road infrastructure, which can be detrimental to the safety of motorcyclists (e.g., wire rope barriers to divide traffic, road repairs resulting in inconsistent road surfaces and loose gravel). Indeed, the MCC argues that road authorities in many states are tasked with reducing fatalities and serious injury, not reducing the overall crash rate and as such, focus on reducing post crash injury of vehicle occupants by reducing the speed of impact. Such an approach is argued to ignore the impact on other road users, such as pedestrians, bicyclists and motorcyclists, when struck by a vehicle. It is argued that to prevent fatalities and serious injuries to these groups of road users, the initial impact must be prevented.

The MCC argued that a preoccupation with enforcing speed limits may in fact result in an increase in rates of crashes, including serious injury and fatal crashes, in the long term. Risk homeostasis theory is used to support this argument, such that rigid enforcement of speed limits is argued to reduce the need for drivers to take responsibility for their own actions. That is, it is suggested that there is the distinct possibility that encouraging drivers to rigidly obey speed limits may also encourage them to ‘switch off’ from the driving task because they are obeying all rules and therefore, by the definition used by authorities, must be safe. The MCC argued that many of the proposals advocated in National Road Safety Strategy (2011-2020) have the potential to have a negative impact on the overall crash rate. It is argued that road and vehicle improvements reduce the need for motorists to concentrate, which may lead to an overall reduction in serious injury to car occupants due to lower speeds, but an increase in injuries to other road user groups due to lack of concentration.

The MCC strongly believes that evidence must be produced to support the long term increased safety of motorcyclists before it will support any introduction of point-to-point speed enforcement. This is consistent with the long term stance of the MCC that any initiative must be evidence-based. As such, the MCC does not support the use of point-to-point speed enforcement. Moreover, it is argued that the whole issue of speed enforcement should be re-visited and researched without the bias perceived to plague previous studies.

The MCC noted that they oppose any enforcement program being outsourced to private companies, given the conflict of interest between profits and road safety. In addition, the MCC expressed opposition to the linking of information collected from point-to-point systems to other databases (e.g., licence and registration, criminal) as it is argued to impinge civil liberties, as well as to any system that can be used to continually track the position of a person or vehicle on a short-term basis. This opposition was linked to such a system being incapable of identifying a driver and thus assuming guilt until that person is proven innocent, which is a principle contrary to the basis of Australian law.

A number of disadvantages associated with point-to-point speed enforcement were reported. The MCC argued that such an approach to enforcement will encourage the increased use of cruise controls and a subsequent reduction in driver concentration and general awareness of road and traffic conditions. In addition, the MCC expressed concern regarding why authorities continually build roads capable of sustained high speed, only to impose speed limits that are perceived to be artificially low. They suggest that roads should be designed to be driven at the desired speed limit, forcing drivers to take responsibility for their own actions.

Australian Trucking Association (ATA)

The ATA argued that any application of point-to-point speed enforcement must be limited to locations where there is a crash history across a short section of road (rather than a black-spot or long length of road). However, it was also argued that evidence of a high number of crashes along a stretch of road would suggest that there were substantial problems associated with that section and that automated enforcement technologies, such as point-to-point cameras may not represent the most efficacious approach to addressing the problems causing this crash history. In addition, it was argued that automated speed enforcement approaches do very little to reduce the immediate infringement, such that offenders are not apprehended and can continue to offend following detection. These concerns were argued to be synonymous with the need to ensure that speed cameras (of any type) are implemented to improve road safety, rather than generate revenue.

Overall, the ATA does not support the use of point-to-point speed enforcement. However it was argued that the approach may represent an effective temporary countermeasure while the underlying deficiencies for an enforced section of road are addressed.

The ATA suggest that speed-related issues are not restricted to heavy vehicles and as such the application of point-to-point enforcement should not be restricted to heavy vehicles. In addition, it is argued that the majority of crashes involving heavy vehicles (and other vehicles) involve other motorists who are typically at fault. Moreover, there was a belief that ‘all’ vehicles must be identified by the system, including motorcycles, pushing for a requirement to use rear-facing cameras. It was argued that most heavy vehicle operators were of the opinion that there is little scientific justification for the focus on heavy vehicles, suggesting that as the industry becomes more compliant with various legislations, new approaches are developed to further regulate the industry.

The ATA suggested that the most effective approach to traffic enforcement was visible police patrols, given that such an approach monitors a greater range of illegal and high-risk driving behaviours, over and above speeding. They suggest speed cameras focus on a single risky behaviour only, and as such are open to criticisms of revenue-raising. In addition, speed cameras of any type were perceived to be susceptible to localised effects only, such that drivers speed up again once passing the enforcement location. While it was acknowledged that point-to-point has the potential to impact behaviour over a longer stretch of road, it was argued that it would have little impact on vehicle speeds outside of the enforcement corridor. Moreover, the ATA argued that the contribution of speed to traffic crashes is often overstated in crash statistics, suggesting that speed may be recorded as a causal/contributing factor when other factors, which are more difficult to ascertain, also contributed to the crash.

The ATA argued that certification and maintenance schedules are critical to the perceived transparency and legitimacy, and subsequent credibility, of point-to-point speed enforcement systems. Moreover, it was argued that management programs must be in place to ensure that no changes to the road alignment and signage in the enforced section have affected issues associated with the calculation of average speed (e.g., shortest practical distance). This factor was argued to represent justification for ensuring enforced sections are not excessively long (e.g., 50 kilometres or greater), such that longer sections of road are more susceptible to changes which affect the validity of certifications. In short, there must be no doubt that vehicles detected by the systems have committed an offence. It was also argued that evidence of certification and calibration should be made publicly available to ensure accountability and increase transparency.

The ATA opposed outsourcing of point-to-point enforcement systems to external organisations, claiming that a conflict of interest exists between profit and road safety. It was argued that governmental organisations must be responsible for the operation of the systems and management of the infringement process. Moreover, it was argued that revenue generated by the systems should be reserved for road safety programs. The ATA also opposed linking data collected from point-to-point systems to other databases, suggesting that enough checks of licence and registration among the trucking industry already exists. Furthermore, it was argued that the data should be made available to vehicle owner and operators so that they, in accordance with chain of responsibility laws, can effectively manage the speeding behaviour of their drivers (owners are given a duty to perform but not the tools to perform it).

The major disadvantage of point-to-point was argued to be the fact that the enforcement approach focuses solely on speed and does not address other high-risk and illegal driving behaviours. Point-to-point was argued to be particularly ineffective when applied to only certain groups of motorists (e.g., heavy vehicles). In addition, the lack of linkages between revenue generated from the speed cameras and road safety programs was perceived to reduce the legitimacy and credibility of the technology. It was argued that the hypothecation of revenue, as well as information of the calibration and certification of enforcement systems, should be made available to the motoring public.

National Measurement Institute (NMI)

The NMI explained their role as being responsible for ‘technical infrastructure’. This means that they set national standards of measurement so that all states work from identical measurement. That is, the measurement of a ‘metre’ or a ‘second’ or any other unit of measurement is the same in all states. This gives strength to legislation involving measurements (e.g., shortest practicable distance) by providing traceability to a common measurement. The Commonwealth does not mandate adherence to these measurements, however if a jurisdiction attempts to regulate their own measurements, the Commonwealth measurements have precedent in any dispute arising. Thus, all states adhere to these standards in association with enforcement of speeds. Traceability allows for measurements to be evidential when pursuing infringements, to the highest standard of law in the country.

The distinction that must be made is that the NMI are not regulators, such that they are not responsible for assessing the accuracy of the measurements used by organisations. Instead, they simply provide the base measurement from which organisations then use as the basis for their own measurements. Thus, surveyors who assess shortest practicable distance must employ tools that have been certified as measuring the various metrics in question with traceability back to the national standards set by the Commonwealth.

It was noted that certification is a general term which has few legal ramifications. It was argued that what is important is that a device has a certificate of patent approval (e.g., type approval for the device); a certificate that it is traceable to the Commonwealth standards of measurement (e.g., shortest practicable distance); and, that is capable of keeping to a particular calibration and was appropriately calibrated at the time of the regulatory measurement (e.g., at the time of the infringement being detected). These certificates can then be used in legal proceedings as evidence of the veracity of the measurements used for the regulatory purpose.

The Office of the Australian Information Commissioner (OAIC)

Please note – the information contained herein is a shortened version of a written response provided by the OAIC.

The OAIC is an independent statutory agency headed by the Australian Information Commissioner. The OAIC has three broad functions:

1. Privacy functions
2. Freedom of information (FOI) functions
3. Information Commissioner functions.

The OAIC has functions under the Privacy Act 1988 (Cth) (Privacy Act). The Act protects the personal (identifiable) information of individuals handled by Australian Government agencies and personal information held by all large private sector organisations, private health service providers and some small businesses.

Application of the Privacy Act to point-to-point speed enforcement systems

The level of privacy protection may vary depending upon the relevant jurisdiction in which the point-to-point speed enforcement system is located. Accordingly, to address any potential gaps in privacy protection the OAIC suggests that each State and Territory should introduce a uniform legislative framework that includes privacy protections and complaint handling mechanisms for point-to-point speed enforcement systems. This may involve one State implementing model legislation setting out the applicable legislative framework and all other States and Territories passing legislation applying or mirroring this framework. A similar approach has been adopted within the context of other national regulatory schemes. The OAIC believes that a best practice guide for the implementation of point-to-point speed enforcement systems would play an important role in any national legislative framework for point-to-point speed enforcement systems.

Regardless of whether speed camera images and other information collected would fall within the Privacy Act's definition of 'personal information', it is preferable for there to be appropriate privacy practices in place across all jurisdictions.

What potential privacy issues are associated with point-to-point speed enforcement systems (e.g., identification of drivers, security and storage of data collected by the system)?

The potential privacy issues associated with point-to-point speed enforcement systems include:

(i) Inconsistent privacy protection across jurisdictions

As stated, given that State and Territory authorities are not subject to the Privacy Act 1988 (Cth), the level of privacy protection may vary depending upon the relevant jurisdiction. For this reason, the OAIC supports the development of a consistent approach to personal information handling practices associated with point-to-point speed enforcement systems. The OAIC believes the best way to achieve this is by each State and Territory imposing a uniform legislative framework that includes privacy protections and complaint handling mechanisms.

(ii) Notice and collection

Generally, under the Privacy Act, individuals are afforded protections to assist in controlling the dissemination of information about them. Legislative frameworks should include a provision that imposes an obligation on State road transport or law enforcement authorities to make individuals aware of how their personal information may be collected, used and disclosed. In addition, any system should be predicated around collecting only the minimum amount of personal information necessary and have legislative measures in place to ensure all information is kept accurate, complete and up to date.

(iii) Use and Disclosure

Legislative frameworks should contain strict provisions around the use and disclosure of personal information collected. Any use or disclosure should only occur if it is related to the specific purpose for which the information has been collected or is otherwise stipulated under the Privacy Act. This approach minimises any unauthorised access to an individual's personal information.

(iv) Security

Legislative frameworks should set out minimum security measures that should be adopted to protect personal information. These measures should canvass all aspects of physical, computer and communications security including user permissions, authentication of access, data encryption, auditing and monitoring requirements.

(v) Access, correction and complaint handling processes

Legislative frameworks should give individuals the opportunity to access and correct (if necessary) information pertaining to them and complain if they are concerned about the way in which their personal information is handled. Instituting such mechanisms facilitates community confidence in the enforcement initiative. A consistent and uniform complaint handling process should be established as part of any uniform legislative framework and is particularly important in circumstances where information collected from point-to-point systems may be shared between various road transport and law enforcement entities.

(vi) Data aggregation and linkage

There is the possibility that the use of point-to-point speed enforcement systems will lead to the aggregation and/or linking of data about an individual (e.g., licence plate numbers linked to an individual's name and address). Data aggregation may enable new uses of personal information beyond the expectations of the individual and without their knowledge or consent. Legislative frameworks should ensure any data aggregation or linkage occurs only in limited circumstances and within strict guidelines.

(vii) Data destruction

Legislative framework should contain a provision which provides for the destruction of data that is no longer required. Implementing retention and disposal policies for information collected will improve the quality of data holdings and ensure any law enforcement decisions resulting from data are made on the highest quality information available.

Question 2: What is the OAIC's perspective on collecting data of drivers who are yet to have committed an offence?

The OAIC recognises that the right to privacy is not absolute. It is necessary to balance privacy with other important social interests, such as the safety and security of the community. The OAIC is of the view that the purposes for which any personal information is collected under a point-to-point speed enforcement system and any uses or disclosures of that information should be clearly articulated in legislation. This will assist in preventing the unnecessary collection of personal information and any unauthorised uses or disclosures. It can also ensure personal information handling under a point-to-point speed enforcement system is subject to appropriate oversight and accountability mechanisms.

Question 3: What is the OAIC's perspective on using the data collected by the system for uses other than speed enforcement (e.g., licence/registration checks, criminal database checks)?

The OAIC believes the uses of personal information collected under a point-to-point speed enforcement system should be clearly articulated in legislation. This can be achieved by way of a privacy impact assessment (PIA) and it enables individuals to be informed about how their personal information may be used or disclosed. Accordingly, using data collected by point-to-point speed enforcement systems for uses other than speed enforcement should only occur in circumstances where there is express legislative authority.

In some circumstances there may be an incremental expansion in the purpose for which a system is used, to the point that it is employed for purposes that were not initially agreed to or envisaged. This expansion in purposes is described as 'function creep' and is usually organic in nature and lacks overall direction, planning or oversight. Individuals may not expect their personal information to be used or disclosed for these incremental purposes nor may they consider such uses or disclosures appropriate. The OAIC is of the view that any proposed use of data for purposes other than speed enforcement should be the subject of a PIA to ensure the correct balance is achieved between individuals' right to privacy and the public interest in maintaining the safety and security of the community.

The former Office of the Privacy Commissioner developed and refined a tool called the '4A Framework' as a guide to balancing these competing priorities. The 4A framework is intended to assist government agencies in considering personal information handling issues in their legislative measures specifically relating to new law enforcement or national security powers. It is underpinned by the recognition that measures that diminish privacy should only be undertaken where these measures are: necessary and proportional to address an identified need, and subject to appropriate and ongoing accountability measures and review. The OAIC suggests that the 4A framework may be a useful tool for ensuring any proposal to use data collected by point-to-point speed enforcement systems for uses other than speed enforcement only apply in circumstances where it is necessary and proportionate to facilitate information sharing between law enforcement agencies undertaking their legitimate functions.

Question 4: What steps could be taken to mitigate any potential privacy issues?

The OAIC has identified the following steps which could be taken to mitigate privacy risks associated with point-to-point speed enforcement systems.

(i) Clearly define the purpose of point-to-point speed enforcement systems

Ensure that the legislation outlines the proposed purposes of point-to-point and what personal information will be necessary to fulfil these proposed purposes, identifying any potential privacy risks and determining whether the same objectives can be met using alternate and less invasive options.

(ii) Privacy Impact Assessment (PIA)

The OAIC strongly recommends that a PIA be conducted to assess the privacy impacts of point-to-point speed enforcement systems. A PIA can assist in assessing the privacy impacts of a project. By identifying any risks, or benefits of particular information handling practices, a PIA can raise options to minimise privacy issues, and improve project implementation and outcomes. A PIA can be updated as a project progresses and more information on the design and functioning becomes available. This can help to inform the development of a uniform privacy framework to be embedded into any best practice guide for the implementation of point-to-point speed enforcement systems.

(iii) Establish a uniform privacy framework

To overcome potential gaps in privacy protection that may arise between different jurisdictions the OAIC suggests a uniform legislative framework which includes privacy protections and complaint handling mechanisms to be adopted across all jurisdictions. A best practice guide could then be developed to supplement the legislative framework and provide guidance to State and Territory road transport and law enforcement agencies on how the scheme could be implemented. It would promote an understanding about how the legislative framework should be applied in practice and also ensure there is consistency across all jurisdictions. For example, the best practice guide could include personal information handling guidelines covering the collection, use, disclosure, accuracy, complaint handling, storage, security, retention and destruction of personal information that falls within the scope of the point-to-point speed enforcement system.

(iv) Function creep

To minimise the potential for function creep to occur the collection and retention of personal information should be limited to that which is necessary to achieve the clearly articulated purposes of point-to-point speed enforcement and should be expressly set out in legislation. *Personal information about other individuals should either not be collected or be deleted as soon as possible*. The expansion of purposes for which a point-to-point speed enforcement system can be used should only occur if the privacy risks are assessed and the new application of point-to-point speed enforcement technology is evaluated in terms of its impact on the privacy of individuals. Any expansion should only proceed if it constitutes a proportionate response to an identified issue.

INFORMATION RETRIEVAL

Austroads, 2012, **Point-to-point speed enforcement**, Sydney, A4, 186 pp.
.AP-R415-12

Keywords:

Automatic Number Plate Recognition (ANPR), average speed enforcement, point-to-point speed enforcement, section control, speed cameras, speed enforcement, speeding, traffic law enforcement.

Abstract:

This report reviews the use of point-to-point speed enforcement internationally in order to provide principles for better practice for its use in Australia and New Zealand. Point-to-point enforcement is a relatively new technological approach to speed enforcement which involves measuring the average speed of vehicles passing a series of cameras, by using automatic number plate recognition (ANPR) and other technologies. The approach has been implemented or trialled in a number of countries including Australia, New Zealand, the United Kingdom, the Netherlands, Austria, Italy, Switzerland and France. The major research activities were undertaken for the preparation of this report included: (1) an extensive review of the international literature; (2) stakeholder consultation with international and domestic organisations.

To date, there have been no formal evaluations of point-to-point speed enforcement in Australia or New Zealand. Evidence from other countries has revealed a number of positive findings including: (i) reductions in average/mean speeds, 85^{th} percentile speeds, the proportion of speeding vehicles and speed variability; (ii) reductions in all crash types, particularly fatal and serious injury crashes; (iii) more homogenised traffic flow and increased traffic capacity resulting from reduced vehicle speed variability and subsequent increased headway; (iv) some evidence of reductions in traffic noise and harmful vehicle emissions; (v) positive attitudes of motorists towards the use of the approach; and (vi) long-term net economic benefits. While methodological limitations are noted across the majority of the published evaluations, the consistency of positive findings is encouraging.

Stakeholder consultations investigated the extent to which point-to-point speed enforcement has been used throughout the world, the technological characteristics of systems used, operational requirements, as well as legislative and broader speed management issues. Based on the findings reported from the stakeholder consultations and literature review, a number of recommendations for better practice are suggested in relation to the development and implementation of point-to-point speed enforcement systems in Australia and New Zealand relating to: (i) operational recommendations; (ii) technological recommendations; (iii) legislative recommendations; (iv) public education recommendations; (v) evaluation recommendations; and, (vi) privacy recommendations.