Defining Enforcement Technology for Managed Motorways

Enforcement Technology Road Map

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Plan Design Enable

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Executive summary

This project was commissioned as DfT TEAR framework task 081 to assist the Highways Agency to identify and capture current and future requirements for enforcement technology to support Managed Motorways (MM). *For purposes of this report the terms Smart Motorways and Managed Motorways are interchangeable. The term Managed Motorways will be used in the remainder of this document as the majority of published documentation still uses this term.*

The HA's MM programme and principles continue to develop and information gathered during the course of the task has particularly identified the need for ongoing flexibility in approach, whilst making best use of the HA's assets and investments. Hence it is recommended that the roadmap is reviewed and updated as new initiatives, information and technology are utilised. During the course of this task, discussions have been held with Critical Stakeholders for the MM programme to identify future enforcement needs, particularly taking account of MM All Lane Running (MMALR). Also, the report considers the available Highways Agency documentation relating to MMALR.

The general conclusions and recommendations are identified under themes of technology requirements, other enforcement, stakeholders, Home Office Type Approval, Police and procurement.

Technology Requirements

A record of the discussions during the stakeholder consultation meeting is provided in Appendix B. In the discussions it was noted that the main safety challenge facing MMALR is not directly related to enforcement; It relates to the detection of stopped vehicles. However, the stakeholder discussions and MM safety reports also identified the need for several enforcement applications to be available in case the compliance issues identified arise. There is concern that if the right tools are not under development, the lead time will be too long to enable implementation. A summary of the enforcement and related applications is also provided. This could be used as a basis for the development of requirement specifications.

Other Enforcement

For MMALR, roadside enforcement technology must be non-invasive (i.e. in-road sensors are not permitted). Equally there are some offences where the crime can only be determined using information, the collection of which cannot be fully automated (e.g. a record of stopping on the hard shoulder alone is not evidence of misuse). VOSA already carry out a range of roadside enforcement initiatives targeted at vehicle condition and roadworthiness. Consequently, the recommendations identify the continued need for in-car systems to support traffic Police and VOSA's ongoing enforcement initiatives for un-roadworthy vehicles.

Stakeholders

Enforcement of MM requires cooperation across stakeholders (DfT, Police, Home Office, VOSA and HA). The working relationship between the Police and the HA is particularly important. Also, enforcement must be publicly and politically acceptable in order to be effective and valued. Hence it is recommended that a coordination group be set up to ensure progress and develop a coherent approach across the stakeholders.

Home Office Type Approval

The UK Home Office Type Approval (HOTA) process is recognised as being one of the most rigorous in the world and it is essential that the integrity of enforcement systems must not be called into question. If it ever is, it must be clearly demonstrable. A clear legal offence definition is needed in order to carry out automatic unattended enforcement. HOTA needs to be accommodated in the planning and groundwork for new applications by allowing for extensive review and update.

Police

There are several organisations that have a direct role in the enforcement process and many others with an indirect role. Deployment of multi-functional systems provides significant shared benefits for traffic policing as long as data protection and privacy issues are properly addressed. It is most important that the HA and the Police cooperate on the enforcement needed for MM.

Procurement

The Highways Agency Digital Enforcement Camera System (HADECS) 3 contract is currently the sole means for procurement of digital camera enforcement systems for MM. HA Procurement advised that the default procurement route for traffic technology goods and services for the HA's Traffic Technology Division (TTD) is the Traffic Management Technology (TMT) Framework. This will remain the default for TTD and it is expected to be extended to 2019.

Nonetheless, the roll out of MMALR will need new enforcement capability at a manageable capital cost and with clearer, less complex operation and maintenance. The reduced access for maintenance on MMALR schemes demands more remote access. Conversely the types of hazards identified for MMALR are likely to need a wider coverage of enforcement. Therefore, the conclusions and recommendations relating to procurement argue for

- Transferring as much responsibility as possible to one organisation;
- A reduction in the number of parties involved in operation and maintenance;
- Flexibility to change enforcement strategies using multifunctional enforcement systems;
- Where realistic, maximising shared benefits of the technology with Police.

Partial privatisation of the enforcement facilities should be considered to enable initial costs to be reduced, but not at the cost of public acceptance.

Bringing it together

The recommendations in this report are wide ranging and provide a way forwards when read together with the concurrent report on the approach to the trial of multifunctional systems. The first MMALR schemes will come on stream in 2014. These will rely on speed enforcement. If other enforcement applications are to be of use to MMALR, work should start as soon as practicable. Also, there needs to be a succession plan HADECS 3. A timeline taking the recommendations and the above considerations into account is provided below.

Smart Motorways Enforcement Technology
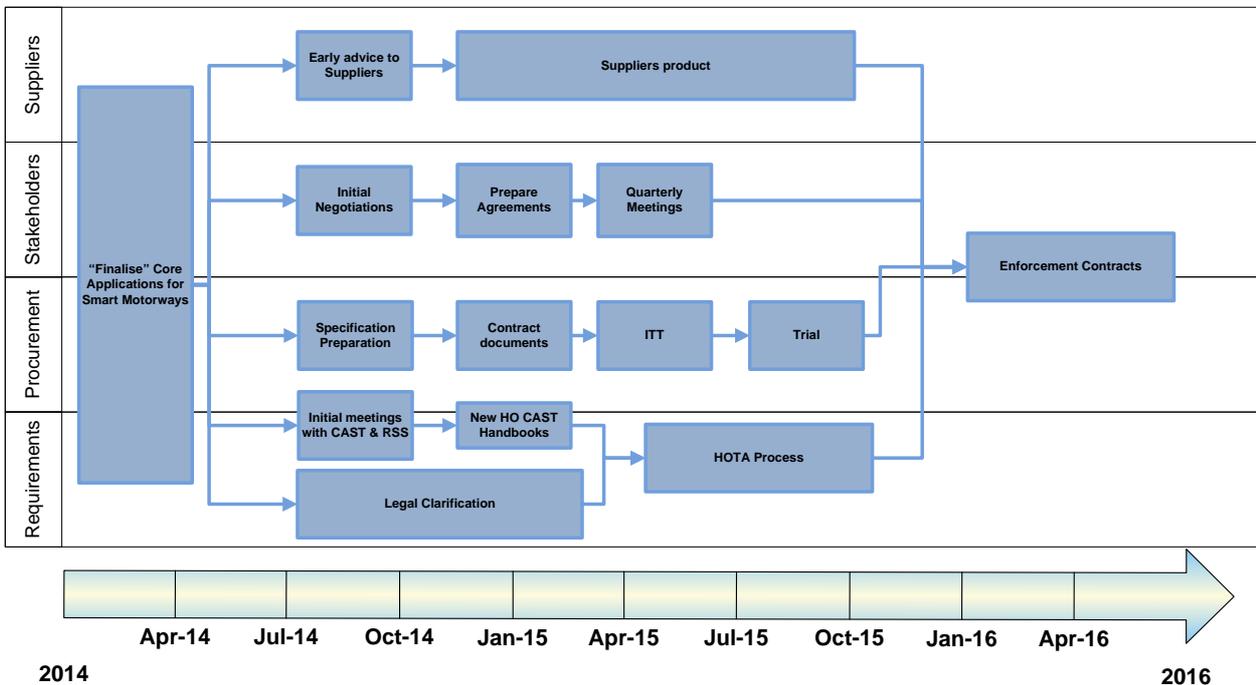
1. Introduction

1.1. Background

This project was commissioned as DfT TEAR framework task 081 to assist the Highways Agency to identify and capture current and future requirements for enforcement technology to support Managed Motorways (MM). *For purposes of this report the terms "Smart Motorways" and "Managed Motorways" are interchangeable. The term "Managed Motorways" will be used in the remainder of this document as the majority of published documentation still uses this term.*

During the course of the task the focus changed from technology requirements capture and development of a specification to;

- Technology consultation to gather the views and requirements of key stakeholders;
- Deliver an approach to the trial and demonstration of enforcement systems with multifunctional capabilities; and
- Identification of a "Road Map" for enforcement technology that could be deployed to maintain or improve the effectiveness of MM.

In the last two decades, the Highways Agency has developed a series of successful technologies that have lead to the current generation of MM. Until now, MM has required a substantial investment in technology and associated infrastructure, with a correspondingly significant impact on the environment (although not as high as the alternative; widening). The Agency is examining how to reduce the provision of technology and infrastructure so that the advantages of MM can be distributed to as much of the motorway and trunk road network as possible. MM All Lane Running (MM ALR) is now being introduced to achieve this end.

1.2. Scope

This document presents the road map supported by information from the technology consultation.

The HA's MM programme and principles continue to develop and information gathered during the course of the task has identified, in particular, the need for ongoing flexibility in approach, whilst making best use of the HA's assets and investments.

Recommendation: It is recommended that the roadmap is reviewed and updated as new initiatives, information and technology are utilised.

1.3. Methodology

The methodology for creating the roadmap followed the stages used to define the structure of this document;

- Stakeholder Consultation;
- Enforcement Applications;
- Technology Road Map;
- Conclusions and Recommendations.

Details of the methodology adopted in each stage are identified in the relevant sections of this document.

2. Stakeholder Consultation

The range of interests in the Managed Motorways community is extremely diverse, but for the purposes of this task, meetings were requested with **critical stakeholders** because without their buy-in, compliance and enforcement technology will not be implemented.

Other groups that were not formally consulted are identified as:

- **Participants**, such as scheme implementers and suppliers, who typically have a role in the implementation of the enforcement on MM-ALR schemes. Whilst this group has much to add to the usage and deployment issues (or vice-versa), they have a limited influence in the requirements.
- **Followers,** such as HATOs or emergency services, have an interest in the subject but are likely to have only a peripheral influence in the specification and deployment of this type of equipment.

The main meetings and discussions that took place with critical stakeholders are summarised in Table 2.1.

Table 2-1   Technology Consultation Meetings with Critical Stakeholders

Meeting subject	Stakeholder Attendance	Date
Inception	Steve Narroway	24-Apr-13
Road Safety Support Ltd. (RSS) and The Home Office's Centre for Applied Science and Technology (CAST) – Conference Call	Trevor Hall (RSS), Ian Humphrey (CAST)	10-May-13
Technology Development	Andy Wilkins	20-May-13
National Policy	Jamie Hassall	13-Jun-13
Senior Responsible Owner (SRO)	Steve Bosanko, Meghann Downing	19-Jun-13
Redirection to Address feedback from SRO	Steve Narroway	12-Jul-13
RSS	Trevor Hall (RSS)	23-Sep-13
Meeting requested with Procurement	Meeting declined	Aug-13

Most of the meetings discussed average speed as the first topic. The agenda for each meeting was based around the typical agenda with supporting slides shown in Appendix A

The applications listed under "Other MM Enforcement Technology" were used as a prompt listed and the list was amended as the consultation progressed.

Appendix B provides a composite set of issues recorded in the meetings, divided into the following subjects.
- Multiple Applications /Sharing Automatic Number Plate Recognition (ANPR)
- Other MM Enforcement Technology
    - New Police Powers
    - Close Following
    - ERA enforcement
    - Hard shoulder misuse
    - Middle Lane Hogging
    - Mobile phone without hands free
    - Red X STOP (Traffic Signs Regulations and General Directions (TSRGD) (Ref 11) Dia 6031.1)
    - Tiger tail/ Swooping
- MM Average Speed Enforcement Trial
- HADECS 3
- Procurement
- Home Office Type Approval
- Compliance Measurement Tool
- Potential Trial Location

Recommendation: It was identified during the discussions with Critical Stakeholders that a summary of the findings of the task should be made available to participants and followers (e.g. enforcement system suppliers and RCC Managers). Presentations to industry bodies such as the ITS UK Enforcement Interest Group and other forums could be used to support this together with articles in industry journals.

Recommendation: Communications with system suppliers should be managed to ensure that the right guidance is provided for them without compromising any commercial arrangements (current or future).

The findings of the Stakeholder Consultations are included in Chapters 3 and 4.

3.   Enforcement Applications

During the technology consultation with critical stakeholders, the following applications were identified (listed alphabetically):

- ANPR based tools;
- Average speed;
- Close following;
- Driving inappropriately after an incident (e.g. slowing down to look, too fast for condition, obstructing emergency services);
- Driving inappropriately for weather conditions;
- Driving whilst using technology (e.g. phone, text, music);
- Illegal vehicles (e.g. over-height, over-weight, wide loads, badly maintained);
- Middle Lane Hogging;
- Misuse of hard shoulder (for MM DHR);
- Stopped Vehicle Detection and Recording;
- Unlawful use of ERAs;
- Unsafe lane changing;
- Violation of motorway closed lane signals;
- Worn tyres.

The Managed Motorways All Lane Running Demonstration of Meeting Safety Objective Report (August 2013) (Ref4) also identifies hazards where the mitigation measures include enforcement cameras (see 4.1.7), as identified below:

- Rapid change of speed
- Motorcycles filter through traffic
- Reversing along slip road
- Entering carriageway unsafely.

Discussions with critical stakeholders included compliance and enforcement functions to support the operation and safety of current and future MM, including All Lane Running (ALR) schemes as advised in Interim Advice Note (IAN) 161/13 (Ref9).

Existing MM with Dynamic Hard shoulder running (DHR), to IAN 111/08 (Ref10) and Controlled Motorways (motorways supported with Variable Mandatory Speed Limits, VMS, with a conventional hard shoulder) were also discussed, as summarised in Table 3-1.

Table 3-1   Managed Motorway Features

Type Of Motorway	VMSL	Hard shoulder	DHR
MM ALR	✓	✗	✗
MM DHR	✓	✓	✓
Controlled Motorway	✓	✓	✗

One of the most important points noted in the stakeholder consultations was the increase in the number of applications that might be needed to support MMALR. If each application were developed separately, it would be impractical and too complex to address all the potential applications.

Recommendation: A multifunctional system should be pursued to deliver a common platform that could be installed wherever necessary and configured for the applications required to deliver flexibility in the implementation of enforcement strategies. An approach to the trial of multifunctional systems is provided in another report produced for this task (ref 8).

For purposes of the trial of multifunctional systems to support MM, the technology consultation identified the following categories:

Mandatory   The capability to provide a number of different enforcement functions from a single unit is essential. However, not all the enforcement functions will necessarily be required to operate simultaneously. The system shall be configurable and, in some instances, a function may be enabled by adding modules (physical or software or firmware). Also, some functions (such as ERA monitoring) may be provided by other systems (e.g. CCTV monitoring with image processing). So, unnecessary functionality should be removable to minimise cost and complexity. Refer to section 3.1

Desirable   Desirable functions are additional enforcement applications that could be advantageous and may be more applicable to other roads. Therefore, they could add value to the usefulness of the system, but they are not essential. Refer to section 3.2

Not applicable   Other potential enforcement functions arose during the course of discussions that were identified as not being applicable to MM, applicable to all roads, or that cannot be addressed by on-road/ roadside based technology (e.g. they might need capability adding to Police vehicles or they can only be dealt with directly by Police Officers). These applications may be important for some authorities, but not in the context of this study. However, multifunctional systems may need to accommodate them in order to achieve economies of scale in manufacturing, operation and support and to attract suppliers into the market. Refer to section 3.3.

Appendix C provides an overview of the applications and approach to the technology in the form of a matrix.

HADECS 3 has been developed to address spot speed enforcement applications and may be considered as a basis for other enforcement systems. Procurement and HADECS 3 are discussed further in section 4.2.

3.1. Mandatory

3.1.1. Average speed

Spot speed enforcement is already addressed by current and future HADECS implementations, so there is no need to include assessment of spot speed. However, average speed enforcement has been the subject of desktop studies, which recognise that it can improve the safety of MM ALR by encouraging smoother driving and more consistent driving habits.

Ref4 identifies that "Rapid change of general vehicle speed" is a hazard that can be mitigated by enforcement technology". Average speed enforcement is also said to encourage smoother, calmer driving behaviour so it could also indirectly contribute to reducing rapid changes in speed, although this would not be detected by this type of enforcement alone.

Average speed enforcement functionality must provide:

- Automatic response to Variable Mandatory Speed Limit (VMSL) settings;
- The capability to measure speed over a zone that may include one or more speed limit displays;
- The functionality to be disabled if there are changing (mixed) speed limits through a measurement zone.

In the course of the consultation, CAST and RSS identified that CAST documentation does not include requirements for using average speed enforcement with VMSL. The process of generating the requirements can take a long time.

Recommendation: It is recommended that discussions are progressed with CAST and RSS to develop a handbook to cover the requirements of average speed enforcement for VMSL.

3.1.2.   **Misuse of hard shoulder (for MM DHR)**

Recent studies have identified a worrying level of misuse of the hard shoulder on existing MM Dynamic Hardshoulder Running (DHR) schemes (Ref 15). The HA is increasing publicity to raise awareness of the dangers and illegality of this behaviour. Also, the HA is working with Police in the West Midlands to improve compliance.

Where MM DHR is implemented, the hard shoulder is effectively only intended for use in breakdowns and emergencies. In such circumstances, no speed limit is displayed over the hard shoulder and occasionally the more explicit Red X (Lane Closed, TSRGD (Ref 11) diagram 5003.1) is displayed.

The criteria for identifying misuse needs to be clarified. Also, Police, Emergency Services, HATOs and maintenance vehicles legitimately use the hard shoulder. So lawful users need to be accommodated. However, outline requirements could include evidence of driving along a closed hard shoulder at speed over a distance inconsistent with a breakdown or without stopping. A system would have to provide sufficient evidence to deal with scenarios of:

- Drivers claiming to have stopped just after the detection;
- A vehicle developing engine trouble, causing it to slow down but not stop;
- Lack of opportunity to rejoin the carriageway;
- HGV inability to accelerate at a sufficient rate to rejoin carriageway.

In particular, illegal stopping cannot be automatically detected and can only be enforced if the actual reason for stopping is witnessed and is illegal (or none of the available mitigating reasons for stopping are witnessed). In 2012 (ref 15) "the Highways Agency recorded 8,655 incidents of drivers stopping on the hard shoulder in a non-emergency situation. Some of the reasons that have been given are:

- Stopping to ring for insurance renewal after realising a policy had expired
- Stopping to take photographs.
- Parents feeding children.
- People taking comfort breaks.
- Stopping to use mobile phones.
- Stopping to rest or sleep because drivers felt tired.
- Stopping to read maps or re-set sat-navs.
- Stopping to pick flowers."

Video and photographic records may be used to provide supporting evidence but this cannot be presented as primary evidence. However, a witness statement can be presented as primary evidence, with video and photographic records as corroboration. So without HOTA equipment-sourced image evidence, the events and behaviours can only be enforced if they are witnessed as they happen.

Nonetheless, driving along the hard shoulder without the intention to stop can be demonstrated by recording vehicles with average speeds that exceed a defined threshold.

Recommendation: Procedures should be developed to advance hardshoulder misuse enforcement that:

1. Accommodate legitimate use by authorised vehicles and drivers;
2. Provide guidance on dealing with evidence obtained from automatic systems to ensure that only illegal use can lead to prosecution.

3.1.3.   **Violation of motorway closed lane signals**

For MM ALR schemes, all lanes are "normally open" (including the hard shoulder). Lanes will need to be closed when vehicles break down, when there are accidents or incidents, or during maintenance activities.

MM ALR needs additional messages to be presented on verge-mounted Variable Message Signs (VMS) using MS4-based displays, including mandatory lane closed displays. Where lane signals are mounted on portal gantries, the standard "Red-X" STOP (TSRGD (Ref11) diagram 6031.1) will be used, as shown below.

Figure 3-1   Red X STOP TSRGD diagram 6031.1
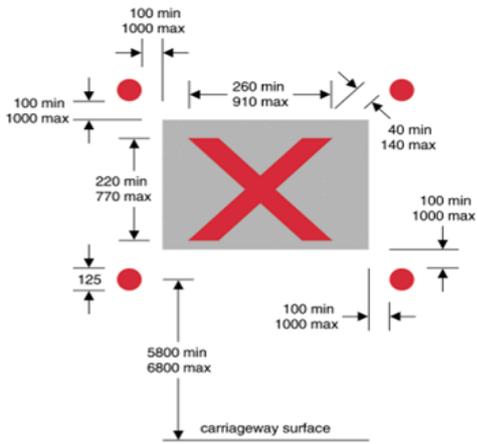
Examples of the additional verge mounted displays that are in the process of authorisation are shown below.

***Table 1.*   Lane(s) Closed - Four Lane Carriageway**

Reproduced from Ref 13, Managed Motorways – All Lanes Running Authorisation for variable message signs capable of showing speed limits, pictograms and text simultaneously

Description	Suggested MS4 Display	Note
Lane 1 Closed (of 4)		Red X width 440mm. Red X height 380mm. Arrow width 420mm. Arrow height 1260mm. See appendix 4.
Lane 4 Closed (of 4)		Red X width 440mm. Red X height 380mm. Arrow width 420mm. Arrow height 1260mm. See appendix 4.
Lane 1 and 2 Closed (of 4)		Red X width 440mm. Red X height 380mm. Arrow width 420mm. Arrow height 1260mm. See appendix 4.
Lanes 3 and 4 Closed (of 4)		Red X width 440mm. Red X height 380mm. Arrow width 420mm. Arrow height 1260mm. See appendix 4.

Description	Suggested MS4 Display	Note
Lane 1 and 4 Closed (of 4)		Red X width 440mm. Red X height 380mm. Arrow width 420mm. Arrow height 1260mm. See appendix 4.
Lane 1, 3 and 4 Closed (of 4)		Red X width 440mm. Red X height 380mm. Arrow width 420mm. Arrow height 1260mm. See appendix 4.
Lane 1, 2 and 4 Closed (of 4)		Red X width 440mm. Red X height 380mm. Arrow width 420mm. Arrow height 1260mm. See appendix 4.
Lanes 1, 2 and 3 Closed (of 4)		Red X width 440mm. Red X height 380mm. Arrow width 420mm. Arrow height 1260mm. See appendix 4.
Lanes 2, 3 and 4 Closed (of 4)		Red X width 440mm. Red X height 380mm. Arrow width 420mm. Arrow height 1260mm. See appendix 4.

Recommendation: Systems that enforce a LANE CLOSED indication to support MM ALR must therefore:

- Recognise all of the variants of display that include at least one LANE CLOSED indication;
- Detect and record vehicles in the closed lane that pass the LANE CLOSED display;
- Provide evidence of sustained use of the hard shoulder by a vehicle at speed;
- Provide a contextual view to ensure that there are no mitigations (e.g. obeying the instruction of a Traffic Officer).

3.1.4. Unlawful use of Emergency Refuge Areas (ERAs)

IAN 161/13 requires that ERAs are provided for MM ALR schemes at regular intervals. ERAs will be the only safe haven within MM ALR schemes and they will normally be monitored by CCTV. However, IAN 161/13 does not require that the CCTV systems read vehicle number plates.

Recommendation: Multifunctional systems need to have the capability, where required, to incorporate add-ons (additional cameras) to:

- Monitor and record occupancy of ERAs;
- Record the ongoing occupancy for a period of time (with a configurable maximum);
- Use ANPR to identify un-obscured number plates of vehicles in the ERA;
- Record the context so that mitigations can be identified.

3.1.5. **ANPR-based tools**

The Police value existing ANPR cameras very highly and they are likely to be receptive to the possibility of accessing cameras owned by the HA. ANPR can be a valuable tool for traffic police to identify uninsured vehicles, stolen vehicles or other vehicle non-compliance.

Historically, the HA has not shared ANPR data, but assets can be shared. Alternatively, HADECS is normally operated by Police or safety camera partnerships and there is a National agreement in place for sharing of HADECS data that allows Police to have ownership of all evidential data as operators. The Highways Agency uses HADECS information only to:

- Produce business cases (using before and after monitoring statistics for compliance with speed limits, number of offences and effectiveness of Variable Speed Limits (VSLs));
- Facilitate and monitor compliance (to enable fine tuning of Operational Regimes, and assess alternative approaches);
- Improve maintenance (by allowing the early flagging of faults and providing information to support the preparation for routine maintenance);
- Assess system performance and reliability.

The CCTV coverage for MM and the National Traffic Information Service (NTIS) is being increased or refreshed with updated communications infrastructures, so the sharing of assets with other organisations (such as the Police) can provide added value and benefits.

The same principles apply to enforcement systems and RSS has indicated that the Association of Chief Police Officers (ACPO) and the Police are keen to make use of ANPR data from enforcement systems. As with HADECS, evidential data would be owned by the Police.

Recommendation: Subject to satisfactory agreement between HA and Police relating to ownership, the exchange of information and the protection of data, the multifunctional system must:

- Provide ANPR data, including supporting images of all number plates recorded;
- Provide tools to manage storage capacity such as;
    - Configurable recording time;
    - Configurable number of recordings;
    - Recording only of specified number plates (or ranges of plates);
    - Exclusion of specified number plates.

3.2. **Desirable**

It would be advantageous if a multifunction enforcement system were to address the following issues;

- Stopped Vehicle Detection and Recording;
- Close following;
- Unsafe lane changing;
- Middle Lane Hogging;
- Additional Hazards from MM Safety Reports.

These issues are discussed in the following sections.

3.2.1. **Stopped Vehicle Detection and Recording**

Detection of stopped vehicles is not an enforcement function, but it has been identified as a significant foreseeable hazards for motorists using MM ALR because vehicles that breakdown and may not be able to get to an ERA and will come to a stop in an unsafe location.

Systems, such as MIDAS, already provide for incident and queue detection. This will be supplemented by CCTV where it is installed.

Rapid response will be essential in preventing secondary accidents and resultant injuries. Multifunctional enforcement systems can supplement such systems.

Unsafe lane changing and middle lane hogging enforcement functions (see below) require the ability to track and record vehicle behaviour. In the case of middle lane hogging, an absence of change needs to be detected. By contrast, rapid change needs to be detected for the enforcement of unsafe lane changing or vehicles stopping.

3.2.2.   Close following

Close following (or "tailgating") can occur on all types of road and it is of particular concern when vehicles are travelling at speed. The safety investigation for MM ALR has identified close following as a hazard that could be reduced by enforcement measures.

However, there is no specific definition for an offence of "following too closely". The Safe Speed organisation (http://www.safespeed.org.uk/tailgate.html) provides the following advice:

> "Tailgating is the dangerous practice of following very close to the vehicle in front. In most circumstances a proper gap is 2 seconds long or one yard for every mph (these are two different ways of expressing the same distance). Close following or the advanced driver's "overtaking position" are about 1 second behind the vehicle in front. Anything closer than about 1 second can reasonably be described as tailgating, although some people only use the term when the following distance is very small, perhaps under one car's length."

The above advice is consistent with the Highway Code. The 2 second rule and headway measured in seconds is the most common measure for close following.

Recommendation: As there is no accepted legal definition, any system providing for close following enforcement will need to be configurable. The following minimum requirements should be expected:

- Configurable headway (or gap) threshold (0.1 to 5 seconds in 0.1 second increments) for recording of vehicles suspected of tailgating;
- Vehicle average speed;
- Evidence of behaviour over a sustained distance (e.g. measurement at 2 points).

3.2.3.   Unsafe lane changing

The safety investigation for MM ALR (Ref 4) has identified unsafe lane changing as a hazard that could be reduced by enforcement measures.

Last second lane switching to leave a motorway is a particular example of bad driving behaviour that that is of concern from the stakeholder discussions.

As there are no firm criteria for identification of this type of behaviour, a system should provide sufficient records of vehicle movements that can be reviewed to determine if there is sufficient evidence for a case to be answered.

Recommendation: Features of an unsafe lane changing enforcement system should include;

- Tracking of individual vehicles changing lane in the field of view of camera;
- Recording of the lane change;
- ANPR.

3.2.4. Middle Lane Hogging

Middle lane hogging was given as an example of an offence when the new the Police powers were announced in 2013. This gave the police the power to issue fixed penalty notices for careless driving (https://www.gov.uk/government/speeches/fixed-penalty-levels-for-motoring-offences).

Recommendation: The enforcement approach to identifying and recording middle lane hogging will be similar to unsafe lane changing, with features that should include;

- Tracking of individual vehicles in field of view of camera;
- Recording of the "no change" in driving behaviour;
- ANPR.

3.2.5. Additional Hazards from MM Safety Reports

Recommendation: As well as the applications identified during the consultation meetings, the MM safety documents published in August 2013 (Ref 4) also identified the following hazards, where mitigations include the use of enforcement cameras:

- Rapid change of speed;
- Motorcycles filter through traffic;
- Entering carriageway unsafely;
- Reversing along slip road.

Of these "Reversing along slip road" has a clear legal definition which could be supported by automatic unattended enforcement systems.

The other hazards do not have a clear definition and are related to aspects of behaviour that may not always be considered unlawful and depend on subjective judgement. As such these applications may potentially be supported by the use of video analytics which could be used to record video if certain behaviours are detected by the way the vehicles move.

3.3. Not applicable for automatic roadside systems

Opportunities for other potential enforcement functions arose during the course of stakeholder discussions, which were either identified as not being directly applicable to MM, or are applicable to all roads, or which cannot be addressed by on-road/roadside-based technology;

- Unroadworthy or illegal vehicles;
- Poor driving behaviour.

3.3.1. Unroadworthy or illegal vehicles

Examples include:
- Worn tyres (discussed in more detail below);
- Illegal vehicles (e.g. over-height;
- Over-weight;
- Wide loads;
- Badly maintained.

There is concern that standards of vehicle maintenance can be insufficient to maximise the safety and capacity performance of highways. The use of un-roadworthy vehicles is not consistent with new developments in the management of modern highways (such as MM) and in discussions, critical stakeholders have expressed concern about accidents associated with worn tyres.

Technology is becoming available to enable measurement of tyre treads on vehicles moving at full speed. However, as measurement requires a close up view of the tyre surface, any accurate method is likely to use in-road sensors. On a Managed Motorway, maintenance requiring work on the road surface is assumed to be unacceptable. Consequently, such devices will only be permitted where maintenance access can be managed with minimal inconvenience to drivers.

Potential options to consider are:

- Slip roads with space to safely support short lane closures for sensor replacement or maintenance;
- Service Areas, where entrance to parking can be controlled – this has particular appeal as it would also allow for possible direct intervention to prevent a vehicle with unsafe tyres proceeding and if detection is located on exit slips, it may attract sponsorship from tyre fitters, who could work with the Police to offer replacement tyres instead of legal action;
- Temporary surface mount sensors may be feasible and might provide the opportunity to transport the systems to different locations.

Therefore, once the technical approach is clearly understood, a separate safety study will be needed to identify whether such measurements are feasible and can be carried out safely.

VOSA already carry out a range of roadside enforcement initiatives targeted at vehicle condition and roadworthiness.

Recommendation: Discussions with VOSA should progress via the HA representative for VOSA (John Walford), to include enforcement against un-roadworthy vehicles and what steps can be taken to ensure the right level of effectiveness is achieved for Managed Motorways.

3.3.2. **Poor Driving Behaviour**

Examples are:

- Driving inappropriately for weather conditions;
- Driving inappropriately after an incident (e.g. slowing down to look, too fast for condition, obstructing emergency services);
- Driving whilst using technology (e.g. phone, text, music).

Recommendation: Roadside systems can provide the capability to monitor and record behaviour (as identified in section 3.2 above), but such systems are unlikely to provide sufficient evidence for enforcement. Police vehicles are already equipped with video recording systems. Therefore, dialogue with traffic Police is recommended to establish what additional in-vehicle tools would assist in improving compliance on MM.

4. Technology Road Map

4.1. Political

4.1.1. Political Acceptability

If used inappropriately, all enforcement has the potential to generate revenue from fines and affect people's livelihood through disqualification.

The Highways Agency is sensitive to the political climate and already takes steps to ensure that enforcement measures are politically, legally and socially acceptable. For example, the National Enforcement Coordinator (NEC) facilitates the setting of national policy for enforcement relating to MM. Also, the NEC agrees operations with the Police and provides a resource for independent verification of evidential trails. The Police also work within policing rules and codes of practice, such as the ACPO Speed enforcement policy guidance (Ref2) and the Home Office Surveillance Camera Code of Practice (Ref3).

However, the public acceptance of new enforcement applications will need established. In the short term, it is advisable to ensure that the necessary checks, balances and transparency are built into the existing roles and organisations. Some of the issues that will need to be addressed are identified in Table 4-1 below. In the longer term, more formal independent industry regulation may be necessary to maintain public acceptance, particularly if there is more private sector involvement with enforcement service delivery, but the costs and complexity of regulation would need to be examined at the time and they may make it undesirable.

Table 4-1   Issues to gain public and political acceptance

Issue	Possible owner(s)
No unnecessary enforcement	DfT, NEC, Police, Police Commissioners
Maximise use of alternative compliance measures	NEC
Comply with guidance, rules or codes of practice put in place by Home Office or ACPO or DfT	Police
Framework for assessment of need	DfT, NEC
Acceptable business case	Satisfy existing HA rules
Programme for enforcement measures	NEC and schemes
Transparency	Information Commissioner's Office (ICO)
Compliance with privacy and data protection	(ICO)

To be publicly and politically acceptable any enforcement measures put in place will need to be balanced and proportionate. A way of achieving this is by putting in place a code of practice or guidance to comply with. This will apply not just to products, but to installation, planning and policy.

Recommendation: It is recommended that the HA identify a coordination group to facilitate progress and a coherent approach across the stakeholders and organisations involved because so many parties are involved over a prolonged period.

See also sections on legal and social issues (Sections 4.3 and 4.5 below).

4.1.2.   **Product development planning**

Solution and product development and approval processes can take years to negotiate successfully and the HA would be open to criticism if measures are not available to maintain highway safety through improved compliance with regulations.

As noted in Table 4-1above, the HA's rules already require forward programmes of works and developments to be based on clear business cases. This means that a clear plan for enforcement development is needed.

Recommendation: Chapter 3 and Appendix C of this document and the accompanying Approach to Trial and Demonstration of Enforcement Technology with Multifunctional Capability report (Ref 8) should be used as a starting point to enable functional requirements to be identified.

4.1.3.   **Police Support**

A forward programme is also needed to ensure funding plans, which will need to allow for potential future political and policy variations. Funding of traffic enforcement cameras has changed over time. From hypothecation (introduced in 1999) to the current reduced-level road safety grant to Local Authorities. (See T Ellis "Need for balance on UK speed enforcement funding cuts", ITS International 2010 (Ref1)).

Currently, the HA has agreements with relevant Police and Safety Camera Partnerships for operation of enforcement within each MM scheme.

Existing arrangements for speed enforcement require a Memorandum of Understanding (MoU) to be signed between the operating Police Force and the HA. As new applications are put into place, MoUs will need to be refreshed/renegotiated with the Police for the schemes affected.

Police Forces are expected to come under pressure to reduce resources on traffic issues, so it is anticipated that they will be looking for an alternative market paradigm (e.g. more private sector involvement).

The potential for the enforcement systems to provide ANPR and other data could be an incentive to share costs of operation.

If other organisations are involved (such as VOSA), similar agreements could be needed.

Recommendation: The current dialogue between the HA and Police concerning MMALR should be expanded to include the wider interests relating to the benefits of sharing the operation of systems.

Recommendation: Enforcement costs can be relatively small (see section 4.2.1, below), so continued investment in partnerships with Police and industry is recommended to achieve the significant benefits of MMALR. The discussions should include the role of the private sector as well as Police, VOSA and the HA.

4.1.4.   **Alternatives to enforcement**

Enforcement should be regarded as a last resort. Alternatives to enforcement will need to be demonstrably less effective or viable than enforcement before enforcement options are pursued. This means that the HA and MM schemes will need to have clear policies and criteria for compliance options and non-enforcement approaches may need to be trialled and evaluated to identify what options are feasible.

Recommendation: Alternative compliance engineering, education and other measures should be considered before enforcement such as:

- Vehicle-activated Signs;
- Varying approach to publicity and informing the public;
- Exploitation of in-car mobile technology to alert drivers and promote good practice;
- Publicity campaigns.

4.1.5.   Privatisation of enforcement

Also discussed in section 4.2 (Economic).

A key barrier to privatisation of enforcement is the profit motive. It explains why un-regulated (or poorly regulated) parking enforcement (i.e. clamping) has low public acceptance. Publicly accountable regulation is essential to establish a market that attracts private investment whilst maintaining public confidence.

The law for speeding requires that the enforcement process includes a Police Officer. The same is likely to apply for most traffic offences on motorways.

Managed Motorways will depend on acceptance and cooperation from travellers, so enforcement activities must be publicly accountable. At the same time the implementation of MMALR, as identified throughout this document, is likely to require a broader range of enforcement applications and more flexibility in deployment, whilst keeping costs realistic.

Recommendation: A partial privatisation model should be considered that allows for all the resources to be provided by a private organisation for the systems to be installed and maintained, with overall performance objectives to achieve compliance. The private company would have no access to fines and would be paid on overall agreed performance measures. Enforcement decisions would continue to be independently made by Police or staff under their direct control.

4.1.6.   Tolling/ road user charging

It is politically unpopular to increase fuel duty, cars are getting more efficient, public transport is becoming more popular, alternative modes are becoming more acceptable, all of which points to a loss of tax from fuel.

A Commons Library Standard Note published 24 October 2013 (SN00442) (Ref12) summarises the current position:

"The Government's present policy is that it remains open to options for using tolls to fund new roads but will not implement tolls on the existing road network."

Road user charging/ tolling may encourage commuters to rethink their travel arrangements by living closer to their workplace, or using public transport. This may increase pressure in congested areas to enforce segregated and/or restricted roadspace (e.g. bus lanes). It may also mean that certain vehicles or journeys may be restricted at certain times (e.g. charging HGVs more during rush hour).

The demand from local authorities for management of roadspace (including enforcement) could increase the demand for a range of enforcement options. Whilst this may not be directly relevant to MM ALR enforcement, there may be pressure in the future from Treasury and from Local Authorities for HA to work in concert with local authorities to achieve tolling aims, which means that tolling enforcement issues will need to be addressed.

Managed Motorways are not being implemented on new roads. Nonetheless, the revenue collection services for tolls will need significant enforcement/recovery operations and there could be commercial interest from service providers to expand their operations into other enforcement spheres.

Recommendation: In the short to medium term, tolling is unlikely to have the geographical coverage of Managed Motorways, so any such measures would be limited in applicability and should only be investigated if changes in government policy and scale for tolling are anticipated.

4.1.7.   Safety of Managed Motorways

The planned introduction of MM ALR is creating significant debate about the safety of all lanes running. The HA has anticipated this and put significant effort into safety-related issues. Ref4 also identifies hazards where the mitigation measures include enforcement cameras.

However, pressure for improved safety may lead to greater political demands for enforcement of risky driving behaviours as well as speeding. The possibility that a major incident unrelated to Managed Motorways might result in more demands for improved safety compliance and enforcement is always present.

Major incidents caused by poor driving or vehicle maintenance may produce step changes in the approach to enforcement.

Recommendation: Preparatory work on the feasibility of enforcement for mitigation of all significant hazards identified for MMALR should be commenced. Ref4 identifies the following hazards (in addition to speeding) that should be mitigated with the use of enforcement cameras:

- Tailgating;
- Motorcycles filtering through traffic;
- Vehicle reversing along exit slip;
- Unsafe lane changing;
- Vehicle enters main carriageway unsafely;
- Driver ignores closed lane(s) signals that are protecting an incident.

4.1.8.   Data Protection and Privacy

The quantity of illegally unregistered, untaxed and uninsured vehicles on the road contributes to increases in insurance premiums. There could be increased pressure for licence, vehicle (tax and MOT) and insurance compliance being supported by more camera based enforcement.

Alternatively, pressure to protect privacy and data could also lead to a reduction in the overall number of cameras being installed for specific and declared purposes in accordance with the published CCTV camera codes of practice.

Currently, driver and vehicle authority offences are detected through database interrogation from ANPR detection, where it is installed and operated by Police. Although this is considered acceptable, the use of cameras can still be perceived as spying. If electronic number plates or other technology were permitted (e.g. for electronic tolling), constant monitoring could be achievable.

As previously noted, tolling is unlikely to be rolled-out on the scale of MM in the short to medium term. However, enforcement systems for MM could be specified and developed to include the capability to record number plates for the Police to check. This would be operated within the constraints of data protection and political acceptability.

Recommendation: There is an existing agreement for sharing of HADECS data between the Police and HA and it is believed that there are similar agreements relating to use of CCTV/ ANPR for specific needs. New, forward-looking agreements should be discussed to ensure the principles of data protection and Freedom of Information are preserved, whilst enabling legitimate policing and enforcement to be carried out using the best tools available.

4.2. Economic

4.2.1. Enforcement cost is low relative to scheme

In the context of MM, enforcement is seen as critical to success because it supports the maintenance of compliance with traffic regulations.

The cost of enforcement is relatively small in comparison to the cost of scheme implementation, with the main costs being for operation and maintenance. A typical scheme using HADECS 2/2.5 could cost;

- Scheme £84m;
- HADECS implement £500k;
- HADECS Maintain £200kpa.

(n.b. The above figures are based on declared scheme cost for M4/M5 Managed Motorway and HADECS costs in Managed Motorway Average Speed Feasibility reports. It is understood the lifetime cost of HADECS 3 can be expected to be lower.)

So, in spite of cost and disruption, enforcement is a relatively modest investment. Combining a wider range of enforcement approaches into one system could improve:

- Value for money; through economies of scale and shared functionality;
- Effectiveness; by allowing for configuration for different offences and
- Mitigation against political and economic changes; by allowing for different approaches and strategies to be implemented.

Procurement options could include commissioning enforcement alongside other key deliverables in schemes (currently, HADECS does not form part of the scheme deliverables). Also, the contract for enforcement equipment should cover the whole life of the equipment. Critical measures/ KPIs should be defined (such as journey times, speed consistency and compliance).

Recommendation: A Study to identify critical performance parameters for enforcement should be commissioned.

Recommendation: Existing performance monitoring tools for measurement within HALOGEN should be developed in order to monitor performance and identify areas of poor compliance. Data exists for speed and flow from MIDAS, which can be used as an independent measure. Other monitoring may be needed (possibly with higher integrity), but MIDAS can provide a tool to make more intelligent use of enforcement.

The delivery of enforcement services should be investigated to determine whether it can be provided as a National / Area based operation. Exploratory discussions with Police/ ACPO may help to identify a joint working model that could support the Police in achieving their targets by providing wider access to the camera technology.

4.2.2. More for less

With more suppliers in the traffic enforcement market in recent years, there is more competition and the cost of the components and modules (such as cameras) has dropped. This means that enforcement systems are offering more sophistication for less cost – i.e. more value for money!

On the expectation that this trend will continue, this means that more tools will be available as suppliers seek to promote added capability. In turn, the availability of multiple functionality within one system will provide for more targeted enforcement when needed. Specific compliance problems will be resolved more quickly and cheaply because there will be more configuration options in the systems.

Recommendation: Suppliers should be encouraged to compete by demonstrating the capabilities of their systems ahead of completion of the current HADECS 3 contract and in time to provide the benefits for the roll out of MMALR. This will realise the benefits of multiple function enforcement equipment.

4.2.3. Procurement policy

Procurement of contracts for development, supply, installation, commissioning and maintenance is normally delivered through competitive tendering. To date, delivery has been separate from the delivery of VMSL and the maintenance is at additional cost.

During the consultation, HA procurement advised that the default procurement route for traffic technology goods and services for the HA's Traffic Technology Division (TTD) is the Traffic Management Technology (TMT) Framework. This is a Government Procurement Service (GPS) framework. The HA is the biggest user of the TMT Framework. The Framework finishes in 2015 and a replacement is planned, which will extend until 2019, so there should be a contract vehicle to deliver HA technology requirements. The Framework will remain the default for TTD.

It is important to maintain the public perception that enforcement is active and capable at all times if required. Currently, this is achieved by requiring a high level of coordination across several organisations. HADECS 3 is already taking a significant step in removing this dependency by removing the need for a direct link between the variable speed limit displays and the enforcement system. However, as identified in section 4.1.5, enforcement for MMALR is likely to require broader and more flexible capability, whilst keeping costs manageable and acceptable.

The current procurement approach, based on supply, installation and maintenance is probably the most cost effective for current needs. However, MMALR enforcement will have to deliver a potentially broader scope and capability than currently. A managed service procurement model would be more aligned with this flexible approach because it would provide regular, predictable cashflows for suppliers and purchasers and agreed rates for new provisions and targeted campaigns.

Recommendation: The feasibility of procuring enforcement systems as a managed service should be investigated.

4.3. Social Influences

4.3.1. Enforcement acceptability

There is a strong link between social and political considerations. In particular, the ethics of enforcement and use of fines as a deterrent are seen as political and social issues.

Enforcement is one factor that can influence compliance (alongside education and engineering, which includes instruction, transparent evaluation and demonstrations). To retain public acceptance, there is a balance to strike between:

- Severity of the penalty (points and fines);
- Alternative measures (education and engineering);
- Enforcement (which should be seen as the last resort, when all other measures are exhausted).

Currently, fines for criminal offences are paid to the treasury and enforcement funding is provided independently. However, the National Driver Offender Retraining Scheme (NDORS) allows for training in lieu of fines and money collected can be used to support enforcement operation as well as paying for the training courses.

Driver opinions and attitudes are key to maintaining compliance. Education, warning, instruction, demonstration and public engagement will be a critical part of enforcement activities in the future. Hence, the use of enforcement needs to be tied in with education and publicity about MM, which should include the reasons for enforcement.

4.3.2. Media Influences

The media can be highly influential on attitudes and the public's perception of enforcement.

PR and media management will continue to be vital to gaining buy-in and cooperation from road users.

4.3.3.   Cost of vehicle ownership

The general increase in traffic volumes undermines the suggestion that the increasing cost of vehicle ownership and operation will reduce the future demand for personal travel. However, the high cost of insurance (particularly for younger drivers) may lead to more vehicles and drivers being uninsured or unlicensed, with increasing demand for enforcement from the law abiding majority.

The Police value existing ANPR cameras very highly, so they are likely to be receptive to the possibility of accessing cameras owned by the HA. Clearly a stronger business case can be made for enforcement cameras if use can be shared because there would be a higher benefit for the little extra cost.

Real time targeting of individuals may become a last resort enforcement tool, relying on tracking and communications. This could provide support for policing as long as it satisfies the ICO and surveillance camera code of practice requirements. A range of enforcement actions may be necessary at different times, so the demand for a flexible enforcement approach may increase.

Recommendation: Systems should be specified to allow for access by Police for purposes other than HA enforcement, should the right criteria be satisfied. This will also require a review of agreements with the Police (ACPO) on data sharing and resources.

4.3.4.   Targeted Enforcement

Growth in traffic appears to be inexorable and although there may have been some slowing in growth during the economic downturn, the trend is still upwards (DfT data and forecasts can be found at https://www.gov.uk/government/collections/road-traffic-statistics). The DfT forecasts continued growth and the mix of road traffic could change as a result of many factors including increased remote working, on line services, social networking and shopping.

Targeted enforcement for different vehicle types may be needed in future. For example HGVs hogging the middle lane or following too close at busy times could cause flow breakdown and increase accidents.

Enforcement monitoring of commercial fleet operators may become acceptable if accident rates, parking or congestion problems start to create problems. This may be in the form of league tables of poor performance (or good performance). Discounts on insurance premiums or vehicle excise duty could be offered to better performers. This means that enforcement would take on more of a measurement/monitoring function for regulators of fleet industries.

Recommendation: The capability to record ANPR data for protected export to licensed third parties should be allowed for in system development.

4.3.5.   Driving Behaviour

Increasing traffic volumes, additional signing and signalling and the unfamiliar environment of MM could increase the importance of driving attentively and with care.

Different approaches to address various driving behaviours may be needed to address the root cause of poor driving. For example, as longevity is increasing, there may also be an increase the number (and proportion) of elderly drivers and some may need more support as they age. It will be politically unacceptable to have an upper age ban on driving, but regular testing may become the norm and skills/behaviour development may be an acceptable alternative to punishment. Consequently, enforcement systems could include a "monitoring" capability to identify poor driving behaviour. There are opportunities to use video analytics to identify excessive swerving and subsequently offer targeted training to registered keepers/drivers.

Whilst driving behaviour enforcement issues may not be central to MMALR operations, if the technology and approach can be presented in a supportive role, it will help to encourage public acceptance of enforcement generally.

Recommendation: Maintain a watching brief on technology developments that could provide driver behaviour enforcement opportunities.

4.3.6. Roadworthiness

In recent years the general condition of vehicles has improved (available statistics (https://www.gov.uk/government/publications/mot-failure-rates-by-month-2008-to-2009-and-2009-to-2010-f0002697) show little change in the rate of MOT failures). However, vehicles are increasingly expensive to maintain, so vital repairs and replacements may be delayed between MOT checks.

Changing social conditions, such as the increase in number of single parent families or single occupier dwellings may increase the demand for cheaper accommodation and cheaper travel, which underlines the pressure on drivers to reduce costs, including delaying maintenance. One of the main potential hazards identified for MMALR is that of stopped vehicles due to breakdown.

Systems to measure tyre pressure and tread condition are under development (refer to chapter 3). Available measurement systems can be deployed for low speed operation to enable pre-selection for enforcement and appear to align best with VOSA's current enforcement role.

Recommendation: Enforcement should be used as part of a publicity campaign regarding vehicle maintenance. Discussions with VOSA, Police and the motoring organisations should progress to raise awareness of the importance of maintaining vehicles in a roadworthy state as well as assessing available technology for enforcement.

4.4. Technological

4.4.1. Video Analytics

For MM, multi-functional systems may be realised with video analytics or image processing to:

- Automatically recognise the instructions displayed by the motorway signs and signals on the same basis as the External Aspect Verification (EAV) used for HADECS 3, and
- Automatically recognise and match vehicle number plates using ANPR from one site to the next on the same basis as existing average speed (distance/ time) systems.

Systems with the above capability could be configured to provide evidence to several offences including:
- Average speed;
- Hard shoulder misuse;
- Lane closed;
- ANPR/ video surveillance to support the Police;

Potential cost reduction and perceived benefits will lead to increased demand for flexibility and multi-functioning equipment.

Recommendation: Suppliers should be encouraged to design and develop multifunctional enforcement systems for trial and demonstration.

4.4.2. Multifunctional Systems

Average speed enforcement systems are now networked and cameras can be configured to provide entry and exit points. There is no technical reason why intermediate cameras could not be added to facilitate tracking of vehicles for some offences.

Image data of wider location/context is likely to become more important in the future to demonstrate that enforcement equipment and relevant signing and information is working and sited correctly.

The technology is available now for multifunctional enforcement, but it has not been delivered as a system because there has been no demand. Yet with the roll out of MM, the flexibility that multifunctional systems can provide in addressing known hazards suggests that their development should be encouraged. The following issues will need to be addressed:

- HOTA requirements for multifunctional systems and individual applications;
- Legal framework to support new applications;
- Proof of concept; i.e. prove technology.

Recommendation: Expressions of interest should be invited for qualifying suppliers to participate in a competition to demonstrate multifunctional capability.

4.4.3. Non-invasive monitoring and detection

Camera systems are being used increasingly to provide non-invasive monitoring from the roadside. For example HADECS includes both across-the-road radar (vehicle detection and speed) and EAV (speed limit display settings). Average speed enforcement systems also operate from the roadside.

However, there are some applications (mostly relating to vehicle roadworthiness) that will rely on in-road sensors, such as vehicle weight, tyre pressures and tread condition. Ideally, these systems should be confined to locations where there is ease of access for maintenance.

Consideration should be given to working with VOSA on initiatives to improve the roadworthiness of vehicles, including the enforcement systems.

Recommendation: Wherever possible, systems to be installed on motorways should be confined to using non-invasive techniques, as is the case with HADECS 3 and average speed systems.

4.4.4. Data communications

There is a choice of data communications services, in the form of the IP connectivity being rolled out across the HA network by the National Roads Transmission Service (NRTS) and mobile/ cellular communications technology such a 3G.

In the interests of reducing infrastructure costs and maximising flexibility of deployment all the data communications, options for enforcement data communication should be available to the HA. Wireless (mobile/cellular) communications are particularly suitable for rapid deployment and temporary installations. They can also be useful in difficult locations, or where there are delays in implementing a fixed cable infrastructure.

Recommendation: Either a review of NRTS services and /or the procurement of specific data communications to support enforcement systems should be considered.

4.4.5.   IPR / Patents

The development of EAV was initiated by the HA under an HA contract, so as long as HA retains its IPR, there will be no licensing issues associated with EAV or similar applications. Also, there are several suppliers of average speed enforcement systems. Hence, there are no IPR/ patent issues relating to these systems that would restrict or increase the cost of development or deployment for the HA.

It is possible that future developments for new applications requiring novel detectors could result in licensing of products to protect suppliers' IPR, which may increase cost and/or restrict development.

Recommendation: Tenderers should continue to be required to identify any IPR or patent issues as part of tender submissions.

4.4.6.   Cost, Quantity, Reliability

Mass produced products tend to be refined as the quantities increase and there is opportunity to make modifications with new batches. To date, quantities of equipment are low (less than 50 HADECS 2/2.5 sites). Whilst HADECS 3 is expected to be used on more schemes, the products are relatively bespoke to MM and are not expected to be manufactured in large quantities. Therefore, opportunities to perfect and upgrade the product will be limited.

If there were wider application of the products and substantial parts of the system could be based on existing products there would be the opportunity to keep costs down and gain the benefit from experience in the wider marketplace.

Development to cover a broader range of applications that can be supported around a core system will potentially increase the volume produced. Equally if products can be based on systems used elsewhere, the overall volumes produced will be significantly higher.

To meet the needs of mitigating hazards identified for MM, it will be more cost effective to share the cost of several applications across one multifunctional system than to develop bespoke systems. Equally, systems based on equipment being produced in quantity for use in similar environments should be more cost effective and reliable.

From the above discussion, it is concluded that enforcement applications for MM will be varied and will be best served through competitive procurement of multifunctional systems or services.

4.4.7.   In-vehicle and Autonomous Technology

Intelligent Speed Adaptation (ISA) and autonomous vehicles are foreseeable (if not certain) to occur, but the timetable is unclear. However, it is evident that large investments are being made in autonomy by automotive suppliers and their introduction in some form should be expected.

Changing from roadside signing to in-vehicle information will remove drivers' excuses for not seeing signs and it could place greater onus on enforcement technology to monitor the performance of specific vehicle systems/components.

The future introduction of partially, or fully-autonomous vehicles will raise issues about liability and attention to the driving task, but reduce the likelihood of driver non-compliance.

The role of the enforcement camera systems is to record evidence of offences. The configuration and "mode of operation" of fully or partially autonomous vehicles will be a significant factor in determining liability (e.g. "fully autonomous", "autonomous brake only", "autonomous parking only", "no autonomy" etc.). This implies that the vehicle will need to report its status to the roadside, or otherwise make its status clear. Therefore, enforcement systems will need to be determined what offence is being committed and by whom.

Driverless vehicles will have to stop for all pedestrians and cyclists. This will place control of traffic into the hands of vulnerable road users and "malicious traffic control" may create demand for "pedestrian enforcement" and/or segregation. Whilst this is not directly relevant to MM, it illustrates how enforcement technology might need to develop in the future and this could influence suppliers of multifunctional enforcement systems.

In the US, black box recorders are required on all new vehicles. In the UK, insurance companies are now offering significant discounts, particularly to younger drivers, for accepting a black box recorder in their vehicle. The role of the black box could be extended to include a more active compliance role, particularly in autonomous vehicles.

For example, speed compliance could be independently checked using GPS built into the black box. Depending on the level of complexity, alarms could be raised and/or the speed could be limited or reported. In the case of autonomous vehicles, an independently provided black box could provide assurance that speed limits and other rules are adhered to.

Recommendation: A feasibility study into the use of black box technology in autonomous vehicles for regulation and /or enforcement should be carried out (i.e. independent monitoring and recording) . This should also include assessment of how to manage enforcement with a mix of vehicles with different levels of autonomy, ranging from conventional vehicles to fully autonomous vehicles.

4.4.8. Dedicated Lanes

The concept of Operational Regimes was included in Active Traffic Management (ATM) (the predecessor of MM) in 2005. Under some circumstances, additional operating regimes may have to be introduced. For example, this might be pursued to manage capacity or emissions (refer to section 4.6) or for emergency response.

MM is a means of extending the life of the motorway by increasing capacity without taking up additional land and minimising construction. As the additional capacity is used up by increased demand over time, other measures may be increasingly introduced and special lanes may become more common (e.g. for Electric Vehicles, Autonomous Vehicles or other restrictions (such as HGVs)). For such initiatives to be successful, compliance will need to be maintained.

Recommendation: The requirements for multifunctional systems should allow for modularity so that enhancement, such as vehicle type classification could be added when known.

4.5. Legal

4.5.1. Legal Status

Issues that have been noted during the technology consultation are:

- HOTA; Enforcement systems must be Home Office Type Approved;
- Legislation must be in place to support specific offence enforcement, including Statutory Instruments (SIs) for schemes;
- Agreements with Police for funding and operation must be legal;
- Data protection: Care must be taken to ensure that proliferation of cameras and applications only targets offenders and complies with the relevant codes of practice.

The legal framework around speeding enforcement is well defined and the basis for operating speed cameras is accepted. However, the same cannot be said for other applications, including those in the published Managed Motorway Safety documentation (Ref 4).

Section 17 of the Road Traffic Regulations 1984 (Ref 16) gives the Secretary of State for Transport powers to treat motorways as special roads and to introduce new legislation (in the form of Sis and Traffic Regulation Orders (TROs)) specifically for motorways.

4.5.2.　　New Applications

Section 17 of the Road Traffic Regulations 1984 provides the opportunity to put legal principles in place to support offences that would be otherwise undefined. Currently, for example, close following (tailgating) does not have a clear definition that is measureable.

In order to fully define and measure the performance of new enforcement measures, definitions will need to be in place. More importantly, if the systems being trialled are to gain HOTA, full legislation will have to be in place. The process that needs to be completed prior to HOTA is outlined as follows;

- Definition agreed;
- Make into law;
- Create HO CAST handbook;
- Procurement specifications;
- Procurement;
- System development and delivery;
- Trial and evaluation.

In some instances, offences could be considered as non-criminal. For non-criminal traffic-related offences, a similar set of steps (albeit possibly less onerous) applies, so the overall cost and time to implement will be broadly similar.

Technology is likely to exist so the development or preparation of the systems for trial cannot be productive until definitions are agreed. Example applications discussed in the Technology Consultation are summarised in the following table.

Table 4-2　　Example Applications & Misdemeanours

Application	Misdemeanour	Conclusion
Average speed	Speeding covered by current legislation.	New HO CAST Handbook required to cover application with VMSL and MM.
Misuse of actively managed hard shoulders – Red X (Lane Closed, TSRGD diagram 5003.1)	Only relevant to MM where there is controlled use of a Hard Shoulder.	Assess success of campaign of working with the Police and using additional PR. If compliance needs to improve further, implement a trial/ evaluation systems to enable a requirement specification to be developed based on lessons learnt. If so, a new HO CAST handbook will be required.
Violation of motorway lane closure aspects – Red X (STOP, TSRGD diagram 6031.1)	Covered under existing legislation for a red light offence.	Propose updates to the existing HO CAST (formerly HOSDB) Red Light Camera Handbook.

Application	Misdemeanour	Conclusion
Unlawful use of ERAs	Would need to demonstrate reason for using ERA. At this point can only be enforced if Police officer attends site.	Although this does not appear to be recorded as a concern in the MM ALR safety documentation, it was raised as an issue in the Technology Consultation. A National SI for MM could be used to clarify the status of the ERA and explicitly state actions that should be taken to legally use an ERA, such as contacting using the Emergency Roadside Telephone (ERT). Any driver not doing this could be deemed to have broken the law. Recommend review of legal status and if needed a new HO CAST handbook would be required.
Driver non-compliance (e.g. insurance), based on ANPR	Various, as identified by the Police.	Specify system requirements to make information available to Police within terms of agreements, codes of practice and privacy and data protection laws.

Recommendation: Before enforcement can take place the offence has to be defined in law and relevant HO CAST handbooks need to be put in place. As the process to achieve this could be prolonged, it is recommended that the process is started as soon as possible, setting priorities against which offence application should dealt with first.

4.5.3.   All Lane Running

Introduction of All Lane Running requires the use of new displays and legends on MS4s. Examples of the displays provided by Netserv are shown in Chapter 2. These displays are in the process of being approved by the Department for Transport (DfT).

The role of enforcement systems is to support compliance with the instructions on the signs and signals. In this regard, enforcement systems should focus on the hazards identified in the safety documentation produced for MM (see section 4.1.7).

4.5.4.   In-vehicle Systems and Autonomous Technology

Refer to section 4.4.7

4.6.   Environmental

4.6.1.   Emissions and Pollution

In some situations, maintaining compliance is being considered to enable emissions to be controlled within the Managed Motorway.

It is tempting to suggest that managing speed compliance will have an impact on emissions (and it probably will to a small extent). Lowering the speed limit could have a positive effect (see The European Environment, 13 Apr 2011, "Do lower speed limits on motorways reduce fuel consumption and pollutant emissions?" (Ref5)) , but the impact of traffic volume also needs to be considered.

It seems reasonable to assume the emissions will increase with traffic volume (i.e. at times of congestion), which is just when speeds will drop anyway, regardless of whether enforcement is present. Therefore something more is needed to reduce emissions. One of the main benefits cited for MM is that they will generate smoother traffic with more predictable journey times. This is already consistent with a desire to reduce emissions.

Therefore, if enforcement measures are to have any impact it will be by:

- Encouraging good driving practice to reduce likelihood of flow breakdown, sharp accelerating and braking;
- Identifying or discouraging vehicles with poor emissions.
  It was identified elsewhere that there might be a role for dedicated lanes for certain types of vehicles. However in the shorter term working with VOSA to identify and discourage high emissions vehicles as well prosecuting owners of vehicle with excessive emissions.

In the future, it is conceivable that political pressure may grow to restrict vehicles with poor emissions, particularly in cities and highly populated areas. This may be restrictions on times, usage or locations.

Traffic pollution and emissions should be of broad concern to everyone because there is increasing evidence of deaths related directly to traffic pollution (Science Daily, Sep. 2013 ,"Road Traffic Pollution Increases Risk of Death for Bronchiectasis Patients" (Ref6)).

Recommendation: Further studies should be carried out to ascertain the range of emissions for typical MM and whether improved compliance will provide worthwhile environmental improvements. The study should include the relationship between parameters such as speed and emissions.

Recommendation: In addition, consideration should be given to working with VOSA, which already carries out roadside emissions checks. Enforcement systems might need to be applied to individual vehicle's emissions. VOSA are already equipped to do this and could support such an initiative (Ref7).

4.6.2.   Driving comfort

MM is said to provide a lower stress, safer driving environment. The current success of MM relies on a high level of cooperation from drivers.

Recommendation: The current approach of "light-touch enforcement" for MM should continue.

Recommendation: New enforcement applications should only be applied alongside other measures (such as publicity, clear signing and guidance) so that drivers understand what is required and why.

Recommendation: Enforcement tools should be available when needed and joint working with the Police and VOSA on all aspects of vehicle roadworthiness should be considered to achieve this.

5.   Conclusions and Recommendations

5.1.   General

During the course of this task, discussions have been held with critical stakeholders for the MM programme to identify future enforcement needs, particularly taking account of MMALR and MM. Also, this report considers the available Highways Agency documentation relating to MMALR, including IAN 161/13 (ref 9) and the MM Safety reports (ref 4).

The conclusions and recommendations identified throughout this report are tabulated under sections covering themes of:

- Technology Requirements;
- Other Enforcement;
- Stakeholders;
- Home Office Type Approval;
- Police;
- Procurement.

Source	Conclusion/ Recommendation
1.2 General	The HA's MM programme and principles continue to develop and information gathered during the course of the task has identified, in particular, the need for ongoing flexibility in approach, whilst making best use of the HA's assets and investments. It is recommended that the roadmap is reviewed and updated as new initiatives, information and technology are utilised.
4.1.4 Alternatives to enforcement	Instead of enforcement, alternative compliance engineering, education and other measures should be considered such as: • Vehicle-activated Signs; • Varying approach to publicity and informing the public; • Exploitation of in-car mobile technology to alert drivers and promote good practice; • Publicity campaigns. Alternatives to enforcement will need to be demonstrably less effective or viable than enforcement. This means that the HA and Managed Motorways schemes will need to trial non-enforcement approaches to identify what options are feasible.

5.2. Technology Requirements

A record of the discussions during the stakeholder consultation is provided in Appendix B. In the discussions, it was noted that the main safety challenge facing MMALR is not directly related to enforcement; it is the detection of stopped vehicles. However, the stakeholder discussions and MM safety reports (Ref 4) also identified the need for several enforcement applications to be available in case the identified compliance issues arise. There is concern that if the right tools are not in development, the lead time will be too long to enable implementation.

Chapter 3 also provides a summary of the enforcement and related applications identified and may be used as a basis for the development of requirement specifications. The main points are tabulated below.

Source	Conclusion/ Recommendation
3 Enforcement Applications	From stakeholder consultations, there are a large number of enforcement applications that might be needed to support MMALR. If each enforcement application were developed separately, it would be impractical and too complex to address all the potential applications. It was identified that a multifunctional system would provide a common platform wherever necessary that could be configured for the applications required. This would enable flexibility in implementation of enforcement strategies. A multifunctional system should be pursued to deliver a common platform and flexibility in the implementation of enforcement strategies.
3.2.5 Additional Hazards from MM Safety Reports	As well as the applications identified during the consultation meetings, the Managed Motorway safety documents published in August 2013 also identified these hazards where mitigations include the use of enforcement cameras: • Rapid change of speed; • Motorcycles filter through traffic; • Entering carriageway unsafely; • Reversing along slip road. • Of these "Reversing along slip road" has a clear legal definition which could be supported by automatic unattended enforcement systems. • • The other hazards do not have a clear definition and are related to aspects of behaviour that may not always be considered unlawful, depending on subjective judgement. As such, these applications may be supported by the use of video analytics, which could be used to record video if certain behaviours are detected from the way the vehicles move

3.1.5 ANPR based tools	Subject to satisfactory agreement between HA and Police relating to ownership, exchange of information and protection of data, the multifunctional system must:
	
	• Provide ANPR data, including supporting images of all number plates recorded;
	• Provide tools to manage storage capacity such as;
	  - Configurable recording time;
	  - Configurable number of recordings;
	  - Recording only of specified number plates (or ranges of plates);
	  - Exclusion of specified number plates.

Source	Conclusion/ Recommendation
3.2.2 Close following	The following minimum requirements should be expected for close-following enforcement, but they do not yet exist, so they will need to be developed: • Configurable headway (or gap) threshold (0.1 to 5 seconds in 0.1 second increments) for recording of vehicles suspected of tailgating; • Vehicle average speed; • Evidence of behaviour over a sustained distance (e.g. measurement at 2 points).
3.2.4 Middle lane hogging	The enforcement approach to identifying and recording middle lane hogging will be similar to unsafe lane changing, with features that should include; • Tracking of individual vehicles in field of view of camera; • Recording of the "no change" in driving behaviour; • ANPR.
3.1.4 Monitoring of ERA	Multifunctional systems need to have the capability, where required, to incorporate add-ons (additional cameras) to: • Monitor and record occupancy of ERAs; • Record the ongoing occupancy for a period of time (with a configurable maximum); • Use ANPR to identify un-obscured number plates of vehicles in the ERA; • Record the context so that mitigations can be identified.
3.1.3 Requirements for enforcement of Lane Closed	To support MM ALR, systems that enforce a LANE CLOSED indication must therefore: • Recognise all of the variants of display that include at least one LANE CLOSED indication; • Detect and record vehicles in the closed lane that pass the LANE CLOSED display; • Provide evidence of sustained use of the hard shoulder by a vehicle at speed; • Provide a contextual view to ensure that there are no mitigations (e.g. obeying the instruction of a Traffic Officer).
4.1.7 Safety of Managed Motorways	Preparatory work on the feasibility of enforcement for mitigation of all significant hazards identified for MMALR should be put in place. Ref4 identifies the following hazards (in addition to speeding) that should be mitigated with the use of enforcement cameras: • Tailgating; • Motorcycles filter through traffic; • Vehicle reversing along exit slip; • Unsafe lane changing; • Vehicle enters main carriageway unsafely; • Driver ignores closed lane(s) signals that are protecting an incident.
3.2.3 Unsafe Lane changing	Features of an unsafe lane changing enforcement system should include; • Tracking of individual vehicles changing lane in the field of view of camera; • Recording of the lane change; • ANPR.
4.4.3 Non-invasive Monitoring and Detection	Wherever possible, systems to be installed on motorways should be confined to using non-invasive techniques, as is the case with HADECS 3 and average speed systems.

Source	Conclusion/ Recommendation
4.4.4 Data Communications	Either a review of NRTS services and /or the procurement of specific data communications to support enforcement systems should be considered.
4.4.8 Dedicated Lanes	The requirements for multifunctional systems should allow for modularity so that enhancement, such as vehicle type classification could be added when known.

5.3.   Other Enforcement

For MMALR, roadside enforcement technology must be non-invasive (i.e. in-road sensors are not acceptable). Equally, there are some offences where the crime can only be determined using other information that cannot be automatically collected. For example a record of stopping on the hard shoulder alone is not evidence of misuse (see section 3.1.2).

Consequently, the recommendations below identify the continued need for in-car systems to support traffic Police and the ongoing enforcement initiatives for un-roadworthy vehicles carried out by VOSA.

Source	Conclusion/ Recommendation
3.3.2 Poor Driving Behaviour	Roadside systems can provide capability to monitor and record behaviour, but they are unlikely to provide sufficient evidence for enforcement. Police vehicles are already equipped with video recording systems. Therefore dialogue with traffic Police is recommended to establish what additional in-vehicle tools would assist in improving compliance on MM. Dialogue with traffic Police is recommended to establish what additional in-vehicle tools might assist in improving compliance for MM.
3.3.1 Un-roadworthy or illegal vehicles	Discussions with VOSA should progress via the HA representative for VOSA (John Walford), to include enforcement against un-roadworthy vehicles and what steps can be taken to ensure the right level of effectiveness is achieved for Managed Motorways.

5.4.   Stakeholders

The key message identified relating to stakeholders is that enforcement of Managed Motorways requires cooperation across government in terms of the DfT, Police, Home Office, VOSA and HA all need to work together. Particular attention needs to be paid to the working relationship and cooperation between the Police and the HA. Also, to be effective and valid, enforcement must be publicly and politically acceptable. Hence the main recommendation to arise relating to ongoing stakeholder issues is to set up a coordination group to facilitate progress and a coherent approach across the stakeholders and organisations involved.

The main recommendations relating to stakeholder issues are tabulated below.

Source	Conclusion/ Recommendation
4.1.8 Data Protection and Privacy	There is an existing agreement for sharing of HADECS data between the Police and HA and it is believed that there are similar agreements relating to use of CCTV/ ANPR for specific needs. New, forward-looking agreements should be discussed to ensure the principles of data protection and Freedom of Information are preserved, whilst enabling legitimate policing and enforcement to be carried out using the best tools available.
3.1.2 Procedures for dealing with Hard shoulder misuse.	Procedures should be developed to advance hardshoulder misuse enforcement that: 1. Accommodate legitimate use by authorised vehicles and drivers; 2. Provide guidance on dealing with evidence obtained from automatic systems to ensure that only illegal use can lead to prosecution.
4.1.1 Political Acceptability	It is recommended that the HA identify a coordination group to facilitate progress and provide a coherent approach across the stakeholders and organisations involved because so many parties are involved over a prolonged period.
2.1 Stakeholder Consultation	A summary of the findings of this task should be made available to participants and followers (such as enforcement system suppliers and RCC Managers). Presentations to industry bodies (such as the ITS UK Enforcement Interest Group and other forums) could be used to support this, together with articles in industry journals.
2.1 Stakeholder Consultation	Communications with system suppliers should be managed to ensure that the right guidance is provided for them without compromising any commercial arrangements.

5.5.   Home Office Type Approval

The UK Home Office Type Approval process is recognised as being one of the most rigorous in the world and it is essential that enforcement systems cannot be called into question and when they are that their integrity can be demonstrated. In order to carry out automatic unattended enforcement a clear legal definition is needed. HOTA need not be a barrier, but does need to be allowed for in the planning and groundwork for new applications need to be prepared in good time to allow for extensive review and update.

These issues are identified in the table below and the sections of this report referred to.

Source	Conclusion/ Recommendation
4.5.2 Home Office Type Approval	Before enforcement can take place, the offence has to be defined in law and relevant HO CAST handbooks need to be put in place. As this process could be prolonged it is recommended that it is started as soon as possible, setting priorities against which offence application should dealt with first.
3.1.1 HOTA for Average Speed Enforcement of VMSL	Currently, the HO CAST documentation does not include requirements for using average speed enforcement with VMSL. It is recommended that discussions are progressed with CAST and RSS to develop a handbook to cover the requirements of average speed enforcement for VMSL.

5.6.   Police

As noted in section 5.4 there are several organisations who have a direct role in the enforcement process and many others with an indirect role. If deployed, multi-functional systems will provide significant shared benefits for traffic policing providing data protection and privacy issues are properly addressed. It is most important that the HA and the police cooperate on the enforcement needed for Managed Motorways, as identified below.

Source	Conclusion/ Recommendation
4.1.3 Police support	The current dialogue between the HA and Police concerning MMALR should be expanded to include the wider interests relating to the benefits of sharing the operation of systems. As identified section 4.2.1 enforcement cost can be relatively small. Therefore to achieve the significant benefits of MMALR, continued investment in partnerships with Police and industry is recommended. The discussions should include the role of the private sector as well as Police, VOSA and the HA.
4.3.3 Police Support	Systems should be specified to allow for access by Police for purposes other than HA enforcement, should the right criteria be satisfied. This will also require a review of agreements with the Police (ACPO) on data sharing and resources.

5.7. Procurement

The HADECS 3 Contract is currently the sole means for procurement of digital camera enforcement systems for Managed Motorways.

HA procurement has advised that the default Procurement route for traffic technology goods and services for TTD is the TMT Framework. This is a GPS framework. The HA is the biggest user of the Framework. The GPS Framework finishes in 2015 and a replacement is planned that will go on until 2019, so a continued procurement route for HA technology requirements is expected up to 2019. The GPS framework will remain the default for TTD.

Nonetheless, the roll-out of MMALR will need new, efficient enforcement capability to provide clearer, less complex operation and maintenance. The reduced access for maintenance demands remote access and, wherever possible, integration to reduce the amount of equipment and "clutter". Conversely, the types of hazards identified for MMALR are likely to need a wider coverage of enforcement. Therefore:

- As much responsibility as possible should be transferred to one organisation, measured by rigorous but realistic KPIs.
- The number of parties involved in operation and maintenance should be reduced.
- There should be greater flexibility to change enforcement strategies using multifunctional enforcement systems that are capable of supporting of multiple applications.
- The benefits of the technology should be shared with Police (and, where possible, the costs).

Partial privatisation of the enforcement facilities should be considered to enable upfront costs to be reduced, as identified below along with other recommendations to ensure public acceptance is maintained.

Source	Conclusion/ Recommendation
4.1.5 Privatisation	A partial privatisation model should be considered that allows for all the resources to be provided by a private organisation for the systems to be installed and maintained, with overall performance objectives to achieve compliance. The private company would have no access to fines and would be paid on overall agreed performance measures. Enforcement decisions would continue to be independently made by Police or staff under their direct control.
4.2.1 Procurement	Procurement options could entail: Inclusion of enforcement commissioning as a key scheme deliverable along side other key deliverables. Currently, HADECS does not form part of the scheme deliverables. The contract for enforcement equipment should cover the whole life of the equipment. A Study should be performed to identify critical performance parameters for enforcement. Critical enforcement performance measures/ KPIs should be defined, such as • Journey times • Speed Consistency • Compliance Existing performance monitoring tools for measurement within HALOGEN should be developed in order to monitor performance and identify areas of poor compliance. Data exists for speed and flow from MIDAS, which can be used as an independent measure. Other monitoring may be needed (possibly with higher integrity), but MIDAS can provide a tool to make more intelligent use of enforcement. The delivery of enforcement services should be investigated to determine whether it can be provided as a National / Area based operation. Exploratory discussions with Police/ ACPO should be pursued to find a joint working model that could support the Police in achieving their targets by providing wider access to the camera technology.

Source	Conclusion/ Recommendation
4.2.2 Procurement	Suppliers should be encouraged to compete by demonstrating the capabilities of their systems ahead of completion of the current HADECS 3 contract and in time to provide the benefits for the roll out of MMALR. This will realise the benefits of multiple function enforcement equipment.
4.2.3 Procurement	The current procurement approach, based on supply, install and maintain appears to be cost effective. However, the potential broader scope and capability that enforcement for MMALR will have to deliver may undermine the value streams that are available from current procurement arrangements.

The feasibility of procuring enforcement systems as a managed service should be investigated. In particular, the investigation should consider the ability to provide flexibility for regular, predictable payments, with agreed costs for targeted campaigns. |
| **4.1.2** Product development | The HA's arrangements already require forward programmes of work and developments to be based on clear business cases. This means that a clear plan for enforcement development is needed.

Chapter 3 together with Appendix C of this document and the accompanying Approach to Trial and Demonstration of Enforcement Technology with Multifunctional Capability report (ref 8) should be used as a starting point to enable functional requirements to be identified. |
| **4.4.2** Multifunctional Systems | Expressions of interest should be invited for qualifying suppliers to participate in a competition to demonstrate multifunctional capability. |
| **4.4.5** IPR/Patents | Tenderers should continue to be required to identify any IPR or patent issues as part of tender submissions. |

5.8. Other Conclusions/Recommendations

Other conclusions and recommendations are outlined in the following table.

Source	Conclusion/ Recommendation
4.1.6 Tolling/ road user charging	In the short to medium term, tolling is unlikely to have the geographical coverage of Managed Motorways, so any such measures would be limited in applicability and should only be investigated if changes in government policy and scale for tolling are anticipated.
4.3.4 Targeted Enforcement	The capability to record ANPR data for protected export to licensed third parties should be allowed for in system development.
4.3.5 Driving Behaviour	The HA should maintain a watching brief on technology developments that could provide driver behaviour enforcement opportunities.
4.3.6 Roadworthiness	Enforcement should be used as part of a publicity campaign regarding vehicle maintenance. Discussions with VOSA, Police and the motoring organisations should progress to raise awareness of the importance of maintaining vehicles in a roadworthy state as well as assessing available technology for enforcement.
4.4.1 Video Analytics	Suppliers should be encouraged to design and develop multifunctional enforcement systems for trial and demonstration.
4.4.7 In-vehicle and autonomous technology	A feasibility study into the use of black box technology in autonomous vehicles for regulation and /or enforcement should be carried out (i.e. independent monitoring and recording). This should also include assessment of how to manage enforcement with a mix of vehicles with different levels of autonomy, ranging from conventional vehicles to fully autonomous vehicles.
4.6.1 Emissions and Pollution	Further studies should be carried out to ascertain the range of emissions for typical MM and whether improved compliance will provide worthwhile environmental improvements. The study should include the relationship between parameters such as speed and emissions. Consideration should be given to working with VOSA, which already carries out roadside emissions checks. Enforcement systems might need to be applied to individual vehicle's emissions. VOSA are already equipped to do this and could support such an initiative (Ref7).
4.6.2 Driving Comfort	The current approach of "light-touch enforcement" for MM should continue. New enforcement applications should only be applied alongside other measures (such as publicity, clear signing and guidance) so that drivers understand what is required and why. Enforcement tools should be available when needed and joint working with the Police and VOSA on all aspects of vehicle roadworthiness should be considered to achieve this.

5.9. Bringing it together

The recommendations in this report are wide ranging and provide a way forward when read together with the accompanying report (Ref 8), which provides an approach to the trial of multifunctional systems.

The programme for roll out of MMALR is well underway, with the first schemes coming on stream in 2014. These schemes will be reliant on speed enforcement and on-road policing. So, the sooner work starts on alternative enforcement applications and approaches, the greater the value to HA.

HADECS 3 is not expected to become obsolete soon, but the long development periods for new enforcement technology means that work should start soon on a plan for succession of HADECS 3 because it's role for enforcing speed is essential.

A timeline taking the recommendations and the above considerations into account is provided below.

Figure 5-1   Smart Motorways Enforcement Technology Programme
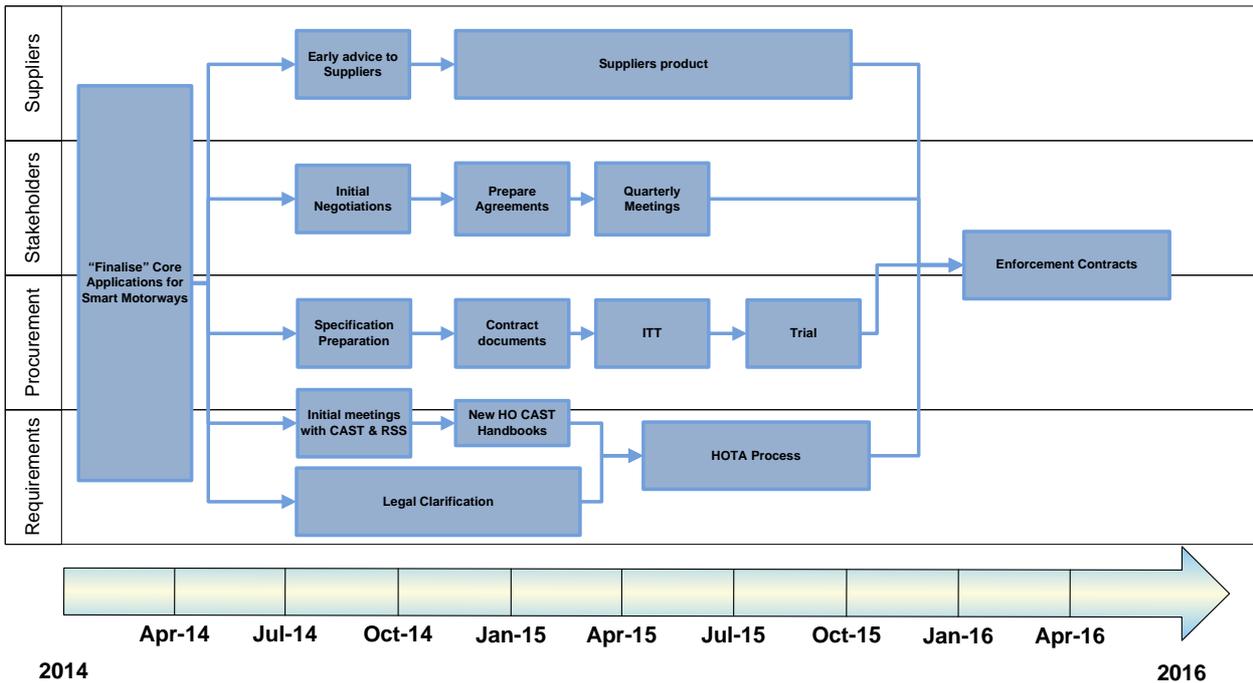
6. References

Ref1 T Ellis "Need for balance on UK speed enforcement funding cuts", ITS International 2010.

Ref2 ACPO, "Speed enforcement policy guidance"

Ref3 Home Office, Surveillance Camera Code of Practice,

Ref4 Highways Agency, 2013, "Managed motorways all lane running: Demonstration of meeting safety objective report"

Ref5 The European Environment, 13 Apr 2011, "Do lower speed limits on motorways reduce fuel consumption and pollutant emissions?", http://www.eea.europa.eu/themes/transport/speed-limits

Ref6 Science Daily, Sep. 2013, "Road Traffic Pollution Increases Risk of Death for Bronchiectasis Patients", http://www.sciencedaily.com/releases/2013/09/130908135621.htm

Ref7 VOSA, July 2003, "Roadside checking of vehicle emissions VOSA Design/Test/795/July/03"

Ref8 Approach to Trial and Demonstration of Enforcement Technology with Multifunctional Capability.

Ref9 The Highways Agency, Interim Advice Note 161/13, Managed Motorways – All Lane Running, August 2013.

Ref10 The Highways Agency, Interim Advice Note 111/08, Managed Motorways implementation guidance – Hard shoulder running, November 2009.

Ref11 Department for Transport, The Traffic Signs Regulations and General Directions (TSRGD), 2002.

Ref12 Louise Butcher, Commons Library Standard Note Published 24 (SN00442), October 2013

Ref13 Highways Agency, Managed Motorways – All Lanes Running Authorisation for variable message signs capable of showing speed limits, pictograms and text simultaneously, May 2013.

Ref14 Atkins, Hard Shoulder Abuse Final Report Version 1.0, December 2012

Ref15 Highways Agency, Press Release "Drivers urged not to risk lives by misusing the upgraded M62 hard shoulder in West Yorkshire", August 2013.

Ref 16 The Road Traffic Regulation Act, 1984.

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Appendices

Appendix A. Slides to support typical meeting

Defining Enforcement Technology for the Managed Motorways Programme

Technology Consultation

1

Agenda

- Introduction

- MM Average Speed Enforcement Trial
    - Principles of Operation
    - Scope of Trial
    - Configurations
    - Mock/ Dummy Deployment
    - Cost Considerations
    - Timescales
    - Procurement

- Other MM Enforcement Technology
    - Close following
    - Hard shoulder misuse
    - ERA enforcement
    - Mobile phone without hands free
    - Red X STOP
    - Middle Lane Hogging
    - Multiple Applications
    - New Police Powers
    - Compliance Measurement Tool
    - Procurement
- Any other business

Full System

Minimal System
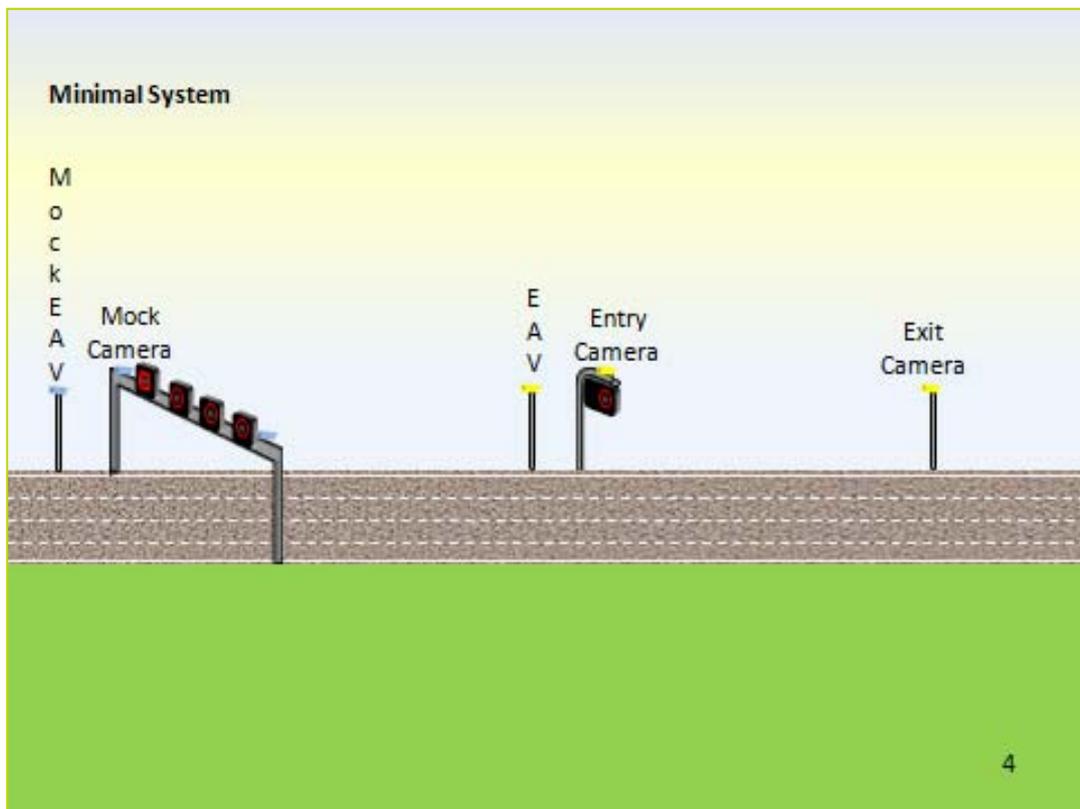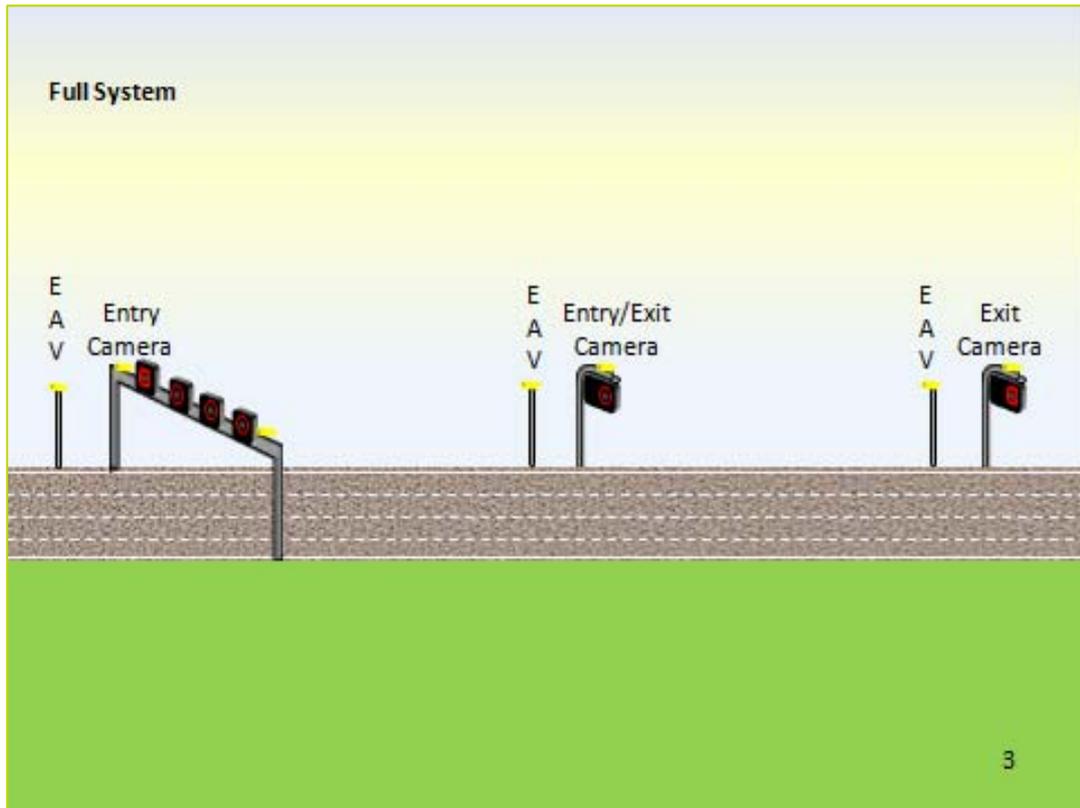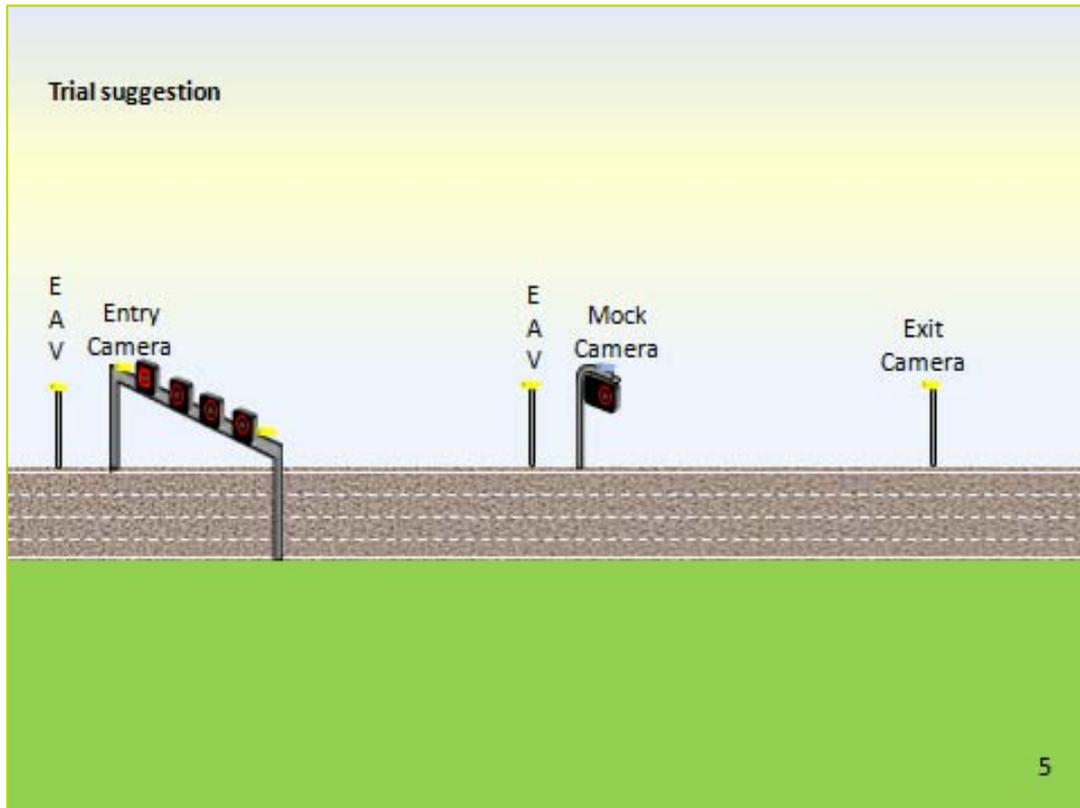
Appendix B. Composite set of points discussed in all meetings

Ref	Subject	DESCRIPTION & ACTION	Meeting	Date Raised	Meeting Item	Origin
1	MM Average Speed Enforcement Trial	Trevor Hall had noted that the current HO handbooks do not cover average speed enforcement with variable speed limits.	Inception 24/04/2013	24/04/2013	1	SN
2	MM Average Speed Enforcement Trial	Possible schemes for a trial of average speed enforcement are M1 Yorkshire or M25 DBFO (where ALR is to be installed).	Inception 24/04/2013	24/04/2013		SN
3	MM Average Speed Enforcement Trial	REC: The NE REC should be contacted if the trial is expected to take place in Yorks.	Inception 24/04/2013	24/04/2013	2.3.4	SN
4	MM Average Speed Enforcement Trial	Procurement: SN advised that John Templer should be able to advise on the contractual procurement approach for a trial.	Inception 24/04/2013	24/04/2013	2.3.5	SN
5	MM Average Speed Enforcement Trial	Enforcement suppliers: It was agreed that contact should be informal and minimised to phone or e-mail if needed. Traffex (JJ visited on 17th April) provided a good opportunity for JJ to make initial contact. JJ advised that the potential trial was not mentioned specifically and discussion was restricted to asking suppliers whether they were considering average speed enforcement for MM. JJ spoke to Peek, Siemens, Serco/Gatso, Vysionics and 3M (PIPS). Vysionics were the only supplier to disclose development of their average speed system to support VMSL and noted that a trial is being organised in S Wales. None of the suppliers spoke specifically about potential to develop systems for other enforcement applications. The general perception is that the suppliers are reluctant to invest significant resources unless there is a demonstrable market opportunity.	Inception 24/04/2013	24/04/2013	2.3.7	JJ
6	MM Average Speed Enforcement Trial	SN noted that consultation for update to TSRGD is expected to start in 2014.	Inception 24/04/2013	24/04/2013	3.2	SN
7	Close Following	TH advised that several suppliers have available technology which could be used to detect vehicles that are following too close.	RSS and CAST 10/05/2013	10/05/2013	3.1.2	TH

Ref	Subject	DESCRIPTION & ACTION	Meeting	Date Raised	Meeting Item	Origin
8	Close Following	TH/ SN not sure if studies to date have shown any conclusive results. JJ said that a study was carried out to see if use of specific messages on existing VMS will act as a deterrent and reduce close following and it is understood the HA are planning to follow this with further study work. If the study shows that messages on signs do not improve compliance sufficiently then enforcement will have to be considered.	RSS and CAST 10/05/2013	10/05/2013	3.1.3	JJ
9	Close Following	JJ noted that close following is not directly defined as an offence and hence could not be directly enforced. TH understands that the HA have special powers to define new offences under Section 17 of the Road Traffic Regulations 1984.	RSS and CAST 10/05/2013	10/05/2013	3.1.4	TH
10	Close Following	JJ observed that the European Tunnel Safety Directive Annex 1, as set down in the Tunnel Safety Directions provides a definition for close following which may be considered as a starting point.	RSS and CAST 10/05/2013	10/05/2013	3.1.5	JJ
11	MM Average Speed Enforcement Trial	TH noted that the technology is already available to carry out average speed enforcement of VMSL, because: a. There are currently 4 suppliers with HOTA for enforcement of fixed speed limits using average speed (Vysionics, 3M(Pips), Redspeed, Siemens). b. The principle of external aspect verification to automatically identify the current speed limit is accepted, subject to being fully proven technically. As a fallback video based records could be used to confirm the speed limits.	RSS and CAST 10/05/2013	10/05/2013	2.1	TH
12	MM Average Speed Enforcement Trial	TH advised that a new HO specification for an Average Speed Enforcement System to support VMSL would be needed to cover the requirements. JJ asked if this would be necessary for a trial if it were to focus on confirming that the technical approach is feasible. TH replied that the technology (i.e. all the key components) already exist so there would be no need to prove the technical approach, but there is a need to establish the effectiveness of this type of enforcement for MM. To achieve this, the system will need HOTA and hence a HO specification will be needed at an early stage. IH agreed with this.	RSS and CAST 10/05/2013	10/05/2013	2.2	TH

Ref	Subject	DESCRIPTION & ACTION	Meeting	Date Raised	Meeting Item	Origin
13	MM Average Speed Enforcement Trial	JJ noted that, in order to be able to implement an average speed solution the costs will need to be manageable. It would not be practical to install equipment at every gantry to track speed limits and record errant vehicles. Hence, in principle, the HA could be looking to install a minimal system, say, with: - entry camera located at a speed limit gantry - exit camera well ahead of the next gantry - install numerous mock cameras and equipment to create the perception of a larger enforcement area.	RSS and CAST 10/05/2013	10/05/2013	2.3	TH
14	MM Average Speed Enforcement Trial	TH confirmed that it would be a matter for the HA to decide on a minimum system. The HO spec would have to allow for systems which extend over more than one speed limit gantry/ sign and spec the requirements for checking that the same speed limit is in force throughout the enforced zone.	RSS and CAST 10/05/2013	10/05/2013		
15	MM Average Speed Enforcement Trial	TH noted that each of the existing HOTAed systems have a minimum baseline and asked if this would be of significance. JJ doubted that it would as it is envisaged that the exit camera for a minimal system would be several hundred metres from the entry camera but well ahead of the next speed limit sign. SN agreed that this would be the most likely scenario. TH advised (confirmed by IH and SC) that minimum baseline for all the currently HOTAed systems ranges from about 75m to 250m.	RSS and CAST 10/05/2013	10/05/2013	2.4	TH
16	Mobile phone without hands free	Mobile phone without hands free: SN noted that this is again accepted to be a problem but is not sure how technology can help.	Technology Development 20/05/2013	20/05/2013	3.5	SN
17	Multiple Applications /Sharing ANPR	Multiple Applications: AW also suggested that, particularly considering red X enforcement, there is potential to consider feasibility of multi-purpose installations. For example if cameras are installed to enforce red X or hard shoulder misuse, they could also potentially be used as average speed cameras.	Technology Development 20/05/2013	20/05/2013	3.7	AW
18	Other MM Enforcement Technology	Other applications were discussed and JJ raised the issue that not all offences will necessarily be classed as criminal. A current example is that the "broken cross" style red X over an actively managed hard shoulder means lane closed and passing this is understood to be a civil not a criminal	Technology Development 20/05/2013	20/05/2013	3.1	SN

Ref	Subject	DESCRIPTION & ACTION	Meeting	Date Raised	Meeting Item	Origin
		offence.				
19	Other MM Enforcement Technology	SN pointed out that Trevor Hall (RSS) had suggested that the Road Traffic Regulations Act section 17 allows the HA to introduce legislation specific to motorways. JJ is to query this with Jamie Hassall and ask if there is the opportunity of the HA to introduce new legislation to cover such issues.	Technology Development 20/05/2013	20/05/2013		
20	Procurement	Procurement: AW advised that the current HADECS 3 contract allows for development for other applications. Equally a task could be awarded under the TMT framework.	Technology Development 20/05/2013	20/05/2013	3.9	AW
21	Red X STOP (TSRGD Dia 6031.1)	Red X STOP: It was noted that incident handling for MMALR will presumably rely on good compliance with Red X to allow emergency services rapid access. However AW also advised that the proposed MS4 display for MMALR lane closed does not include flashing red lanterns around the red X, so the legal standing has yet to be clarified.	Technology Development 20/05/2013	20/05/2013	3.6	AW
22	ERA enforcement	ERA enforcement: As there is no hard shoulder with MMALR it is all the more important that ERAs are kept free for emergencies. JJ advised that it is already reported as a safety concern for existing MM schemes.	Technology Development 20/05/2013	20/05/2013	3.4	JJ
23	MM Average Speed Enforcement Trial	JJ confirmed that it is currently intended to prepare a specification for the requirements of Trial of Average Speed enforcement for Managed Motorways. JJ advised that RSS (Trevor Hall) had expressed the view that the technology is available so a trial should be to assess effectiveness and not the capability of the technology.	National Policy 13/06/2013	13/06/2013	2.1	JJ
24	MM Average Speed Enforcement Trial	SN said that Vysionics have already started setting up a trial of Average Speed Enforcement for VMSL in Wales and had attended a meeting with Trevor Hall (RSS), Andrew Page-Dove and Vysionics to discuss the trial.	National Policy 13/06/2013	13/06/2013	2.2	SN
25	MM Average Speed Enforcement Trial	JH and SN agreed that it would be advisable for the HA to confirm to RSS that there would be interest in average speed enforcement systems to support VMSL being developed and put forward for HOTA.	National Policy 13/06/2013	13/06/2013	2.3	SN
26	MM Average Speed Enforcement	JH noted that he sees that Average Speed Enforcement would be especially important for All Lane Running because there will be	National Policy 13/06/2013	13/06/2013	2.4	JH

Ref	Subject	DESCRIPTION & ACTION	Meeting	Date Raised	Meeting Item	Origin
	Trial	no Hard Shoulder and the spacing between signalling gantries will be increased and in principle Average Speed Enforcement will maintain compliance over longer distances.				
27	MM Average Speed Enforcement Trial	The variations in system configuration were discussed and it was noted that it is technically feasible for the speed limit at every signal gantry to be monitored and hence to enforce a whole link providing the speed limits are all the same.	National Policy 13/06/2013	13/06/2013	2.5.1	JJ
28	MM Average Speed Enforcement Trial	However JH is also concerned that the system can respond to changing speed limits and not end up being disabled for long periods because the speed limits are not the same along a link.	National Policy 13/06/2013	13/06/2013	2.5.2	JH
29	MM Average Speed Enforcement Trial	JH noted that the Siemens system is compact, with no roadside control equipment being needed as all the essential technology is in the camera unit.	National Policy 13/06/2013	13/06/2013	2.5.3	JH
30	MM Average Speed Enforcement Trial	JH confirmed that he is certainly open to the concept of using a minimum configuration where maybe as little as one speed limit sign is monitored with an "exit" camera well ahead of the following speed limit signs.	National Policy 13/06/2013	13/06/2013	2.5.4	JH
31	MM Average Speed Enforcement Trial	Based on the above discussion JH would be interested to know the scope and scale of the system that would be permitted for HOTA i.e. would a minimum system be acceptable?	National Policy 13/06/2013	13/06/2013	2.5.5	JH
32	MM Average Speed Enforcement Trial	SN also observed that it would be useful to assess the amount of down time due to mismatching speed limits versus the length of the zone enforced. JJ believes it should be possible to do an assessment using signal setting data from HALOGEN and will make enquiries about the feasibility. It was agreed that this information would be useful as it is important the method of enforcement should not dictate/ influence the speed limit settings.	National Policy 13/06/2013	13/06/2013	2.5.6	SN
33	MM Average Speed Enforcement Trial	The consensus was that a trial should: - Be on road - Include at least 2 speed limit signs - Include 3 entry/exit camera locations - Assess the effectiveness of enforcement and not the technology	National Policy 13/06/2013	13/06/2013	2.5.7	JH, SN, JJ
34	MM Average Speed Enforcement Trial	SN suggested that consideration could be given to enforcing NSL only but over a wide area as, in principle, the display of lower speed limits or other displays does not affect the fact NSL is being exceeded. JH agreed that this is worth further discussion as NSL could be enforced without the need to	National Policy 13/06/2013	13/06/2013	2.5.8	SN

Ref	Subject	DESCRIPTION & ACTION	Meeting	Date Raised	Meeting Item	Origin
		monitor the signs as the speed limit cannot exceed NSL. All Lane Running requires more need to consider safety and it would be more important to ensure compliance with NSL, given that there is no hard shoulder. This should be included in future discussions with RSS/ CAST.				
35	Mobile phone without hands free	It was agreed that there is nothing specific about this offence to Managed Motorway, although consideration could be given to using video surveillance to assess its prevalence when ALR schemes are implemented.	National Policy 13/06/2013	13/06/2013		SN, JH, JJ
36	Multiple Applications /Sharing ANPR	JH advised that the HA stance has always been not to share ANPR data as such but assets can be shared. In fact the HA are looking to upgrade the NTIS cameras so there is an opportunity to build in shared use requirements for minimal cost i.e. to enable the Police and operators to share the use of the same camera.	National Policy 13/06/2013	13/06/2013	3.9.1	JH
37	Multiple Applications /Sharing ANPR	SN said that the Police value existing ANPR cameras very highly so they are likely to be receptive to the possibility of accessing cameras owned by the HA. Clearly a stronger business case can be made if use can be shared as there would be a higher benefit for the little extra cost.	National Policy 13/06/2013	13/06/2013	3.9.2	SN
38	New Police Powers	The new Police Powers announced recently apply to careless driving and allow fixed penalty notices to be issued. The new powers are particularly targeted at tailgating (close following) and middle lane hogging.	National Policy 13/06/2013	13/06/2013		
39	Other MM Enforcement Technology	JH said that there is some concern with the following types of problem which may warrant further consideration, although they are not unique to Managed Motorways: - towing vehicles that break the speed limit; - overweight vehicles – there are 10 WIM sites operated by VOSA; - illegal tyres; - driving while tired.	National Policy 13/06/2013	13/06/2013		JH
40	Potential Trial Location	Potential Trial Location: SN noted that the M25 DBFO (J25-27) scheme will be the first to go live with ALR. The first scheme that will be directly controlled by the HA will be on the M1 (location TBC).	National Policy 13/06/2013	13/06/2013	2.8	SN
41	Procurement	Procurement JH said that the trial of Average Speed Enforcement should be put out to competitive tender.	National Policy 13/06/2013	13/06/2013	2.6	JH
42	Procurement	There was some discussion about approach to procurement. It was observed that in	National Policy	13/06/2013		

Ref	Subject	DESCRIPTION & ACTION	Meeting	Date Raised	Meeting Item	Origin
		some cases the delivery could be wrapped into a "Compliance Service" with the provider being tied to a defined performance.	13/06/2013			
43	Procurement	Other funding contribution might be achieved through driver training in lieu of fines.	National Policy 13/06/2013	13/06/2013		
44	Red X STOP (TSRGD Dia 6031.1)	There was some discussion about the legal difference between the Red X STOP (solid X with flashing red lanterns) and the Red X Lane Closed (in the form of a broken cross to TSRGD Dia 5003.1). SN to check with Craig Benson of what offences are committed for passing both types of red X.	National Policy 13/06/2013	13/06/2013	3.4.1	
45	Red X STOP (TSRGD Dia 6031.1)	JH noted that the Red X STOP is for display over a lane and that the display on an MS4 could only be used for closing the whole carriageway. The displays to support lane closure for incident management for ALR have yet to be finalised.	National Policy 13/06/2013	13/06/2013	3.4.2	JH
46	Red X STOP (TSRGD Dia 6031.1)	Compliance on existing conventional schemes is considered to be poor and therefore there is concern about the approach to take for ALR.	National Policy 13/06/2013	13/06/2013	3.4.3	JH
47	Red X STOP (TSRGD Dia 6031.1)	It was observed that Police vehicles attending incidents are equipped with cameras as standard. Consideration should be given to fitting cameras into HATO vehicles.	National Policy 13/06/2013	13/06/2013	3.4.4	JH
48	Tiger tail/ Swooping	JH said an additional concern that had been raised in relation to ALR is that of drivers trying to leave the motorway at the last moment and crossing the shaded area. The consequences of unsafe manoeuvres could be all the more serious and it was suggested that consideration should be given to additional cameras at junctions.	National Policy 13/06/2013	13/06/2013		JH
49	Tiger tail/ Swooping	It was also suggested that Steve Bosanko should be asked if there are any plans to monitor this type of behaviour when ALR is introduced to identify if there is a problem at an early stage.	National Policy 13/06/2013	13/06/2013		JH
50	Close following	JH Confirmed that section 17 of the Road Traffic Regulations 1984 give the HA powers to treat motorways as special roads and hence introduce new legislation (in the form of SIs and TROs) specifically for motorways.	National Policy 13/06/2013	13/06/2013	3.2.1	JH
51	Close following	JJ mentioned that the Road Tunnel Safety Regulations "transpose" the European Road Tunnel Directive into UK law. The Directive includes Annex 1 which states that vehicles should follow no closer than 1 vehicle every 2 seconds. The distance should be doubled for HGVs. JJ suggested that the approach (i.e.	National Policy 13/06/2013	13/06/2013	3.2.2	JJ

Ref	Subject	DESCRIPTION & ACTION	Meeting	Date Raised	Meeting Item	Origin
		measuring time between vehicles) could form a starting point in formulating legislation for Close Following as an offence on motorways.				
52	Close following	JH advised that an SI could be written to cover Close Following on motorways.	National Policy 13/06/2013	13/06/2013	3.2.3	JH
53	Compliance Measurement Tool	JH agreed that ready access to compliance data is definitely useful and advised that this is being progressed by Steve Bosanko and should be discussed with him..	National Policy 13/06/2013	13/06/2013		JH
54	ERA enforcement	It was noted that the ERAs will be the only safe haven within an ALR scheme and they will normally be monitored by CCTV. Hence it was agreed that there will be no need for bespoke enforcement equipment. However it was noted that the scheme design advice should be to ensure that vehicle number plates can be seen using the CCTV provided for the ERA.	National Policy 13/06/2013	13/06/2013		
55	HADECS 3	SN advised that HADECS 3 would be a very useful tool for other enforcement applications, such as Red X enforcement as it will have the capability to automatically recognise sign settings.	National Policy 13/06/2013	13/06/2013		SN
56	Hard shoulder misuse	JH advised that some work is already being done on Hard Shoulder misuse. There was a meeting with W Mids Police/ CMPG are concerned about the level of compliance in the W Midlands. CMPG are happy to work with the HA to send out warning letters. JH said that there is some evidence that early morning offences are only misunderstandings and drivers identified respond well to the issue being explained.	National Policy 13/06/2013	13/06/2013		JH
57	Hard shoulder misuse	JH went on to say that WMP had indicated that driver training in lieu of fines would be worthwhile for this type of offence.	National Policy 13/06/2013	13/06/2013		
58	Home Office Type Approval	JH suggested that the possible separation of HOTA of the EAV from the enforcement system should be discussed with RSS/ CAST.	National Policy 13/06/2013	13/06/2013	2.7.1	JH
59	Home Office Type Approval	The alternative of issuing warning letters instead of fines was discussed to reduce the need for a HOTAed system for purposes of the trial. JH favours using a system with HOTA for trials because if drivers cannot be prosecuted the effectiveness on compliance could be diluted.	National Policy 13/06/2013	13/06/2013	2.7.2	JH
60	Middle Lane Hogging	JH suggested that, although it would be difficult an offence for middle lane hogging	National Policy	13/06/2013		JH

Ref	Subject	DESCRIPTION & ACTION	Meeting	Date Raised	Meeting Item	Origin
		could be defined.	13/06/2013			
61	Hard shoulder misuse	There are concerns with Hard shoulder misuse and the HA National Policy team are working with CMPG to raise awareness and reduce the level of misuse in the W Midlands. SN advised that the potential for enforcement using a system based on HADECS 3 is being investigated.	SRO 19/06/2013	19/06/2013		SN
62	MM Average Speed Enforcement Trial	JJ explained the basis of the configurations and issues raised in previous discussions with Jamie Hassall (National Policy, National Enforcement Coordination), Andy Wilkins (HA technology purchase and HADECS 3 contracts), RSS and CAST (Home Office Type Approval and Policing).	SRO 19/06/2013	19/06/2013	2.2	JJ
63	MM Average Speed Enforcement Trial	- Longer measurement zones, for example to cover a whole link, would result in downtime whenever speed limits vary along the link, depending upon the configuration. There is, therefore, a need to investigate the amount of time speed limits vary along a typical motorway link. Also to find out investigate the relationship between downtime arising from conflicting speed limits with measurement zone length.	SRO 19/06/2013	19/06/2013		JJ
64	MM Average Speed Enforcement Trial	- Clearly the more speed limit displays that have to be covered, the more complex the system. JJ noted that it is normal practice to use mock/ non-live cameras with current average speed systems and it would be reasonable to use a similar approach for systems enforcing VMSL.	SRO 19/06/2013	19/06/2013		JJ
65	MM Average Speed Enforcement Trial	SB, MD noted that examples provided show the enforcement measurement zone starting at the beginning of a link and commented that consideration could be given to the measurement zone being at the end of a link instead.	SRO 19/06/2013	19/06/2013	2.3	SB, MD
66	MM Average Speed Enforcement Trial	JJ noted that compliance along a link can be monitored using data available from the existing MIDAS loops.	SRO 19/06/2013	19/06/2013		SB, MD
67	MM Average Speed Enforcement Trial	It was commented that the simplest systems will be the most reliable. SB wondered if Average speed systems could prove less reliable than HADECS.	SRO 19/06/2013	19/06/2013	2.4	SB
68	Procurement	It was suggested that if Average Speed enforcement is needed to support MMALR procurement should commence in the next 2 years. SB noted that a business case would need to be prepared.	SRO 19/06/2013	19/06/2013		SB

Ref	Subject	DESCRIPTION & ACTION	Meeting	Date Raised	Meeting Item	Origin
69	Pros and cons of average speed	SB asked if there are any figures for the improvements provided by average speed enforcement in roadworks compared with spot speed. JJ believes that there is plenty of information from Vysionics and other suppliers of average speed enforcement systems, but is not aware of any independent reports.	SRO 19/06/2013	19/06/2013		SB
70	Red X STOP (TSRGD Dia 6031.1)	SB and MD confirmed that there will be a need to enforce the stop signals (when defined) for MMALR. It was agreed that the criteria for determining an offence has been committed are more straightforward to define, being the same as that for red traffic lights.	SRO 19/06/2013	19/06/2013		SB, MD
71	HADECS 3	*We would like to investigate what would need to be done to trial or implement these, but also to get a wider view of what HADECS 3 might be capable of outside the realm of enforcement. There may be other areas (e.g. safety, intelligence-gathering) where we can maximise the benefit of HADECS 3 without introducing additional enforcement, and Andrew was interested in exploring these."*	Redirection to Address feedback from SRO 12/07/2013	12/07/2013		
72	MM Average Speed Enforcement Trial	*Mainly Andrew would rather concentrate on developing our capability under HADECS 3 rather than investigating a new system; therefore could you please stop work on the ASE trial specification.*	Redirection to Address feedback from SRO 12/07/2013	12/07/2013		
73	Multiple Applications /Sharing ANPR	JJ advised that part of the discussion with Trevor Hall was about the relevance of trials and multiple applications. There would be support from ACPO and RSS for systems which can be used for more than one enforcement application.	Redirection to Address feedback from SRO 12/07/2013	12/07/2013	2.4	JJ
74	Other offences:	*We would like to concentrate on the second part of the work, as we all agreed there is lots of interesting potential here. We don't think there is a specific need for the 'road-map' (at least, not solely related to enforcement), as the immediate priorities for future use of HADECS have already been defined; these are stopped vehicle detection and closed-lane enforcement.*	Redirection to Address feedback from SRO 12/07/2013	12/07/2013		
75	Procurement	It would also be useful to identify potential approaches to procurement or whether a less formal approach could be carried out as well as giving consideration to the potential for developing HADECS 3 to address other applications.	Redirection to Address feedback from SRO 12/07/2013	12/07/2013	2.7	

| Ref	Subject	DESCRIPTION & ACTION	Meeting	Date Raised	Meeting Item	Origin
76	Close following	Close following was discussed and it was noted that the there is no offence which specifically covers close following, so clarification of legislation would be needed before enforcement could be defined. JJ noted that the there is a definition in the European Tunnel Safety Directive, based on vehicles being separated by more than 2 seconds, which may provide a starting point for a definition for Managed Motorways. AW pointed out that standard advice used to be "you are a fool if you don't obey the 2 second rule".	Technology Development 20/05/2013	20/05/2013	3.2	AW
77	Compliance Measurement Tool	Compliance Measurement Tool: It would also be useful to know where there is poor compliance to potentially allow the enforcement solution to be tailored to the location.	Technology Development 20/05/2013	20/05/2013	3.8	SN
78	Hard shoulder misuse	Hard shoulder misuse is now considered to be a problem and JJ advised that Paul Marshall is looking at how this can be enforced.	Technology Development 20/05/2013	20/05/2013	3.3	JJ
79	MM Average Speed Enforcement Trial	The principles of a trial of average speed enforcement to support VMSL were discussed and AW supported the view that the technology components are essentially available so a trial should go beyond proving the technology to demonstrate the effectiveness of average speed enforcement as a compliance tool.	Technology Development 20/05/2013	20/05/2013	2.1	AW
80	MM Average Speed Enforcement Trial	It was noted that Vysionics, with EAV provided by SSL, are progressing with a trial/ demonstration of average speed enforcement on the M4 in S Wales.	Technology Development 20/05/2013	20/05/2013	2.2	SN
81	MM Average Speed Enforcement Trial	AW is of the opinion that the minimum system should include at least 2 speed limit signs, but ideally extend to include a whole motorway link. JJ noted that the system costs will go up according to the number of locations monitored. AW pointed out that if multiple speed limit signs were included in one measurement area then only 1 entry and 1 exit camera are needed. It was concluded that the procurement process should obtain prices for a variety of configurations, to enable the optimum cost / benefit to be determined. It was also noted that the complexity and corresponding cost can be expected to continue to reduce; hence a wider coverage for lower cost could be possible in future.	Technology Development 20/05/2013	20/05/2013	2.3	AW

Ref	Subject	DESCRIPTION & ACTION	Meeting	Date Raised	Meeting Item	Origin
82	MM Average Speed Enforcement Trial	Potential configurations could be summarised as: 1. Entry Camera at sign + Exit Camera before next sign 2. Entry Camera at sign + Exit Camera at next EAV pole 3. Entry Camera at sign + Exit Camera at next sign 4. Entry Camera at sign + Exit Camera after several signs but before next Junction Exit "sign" refers to a VMSL display, such as gantry AMI or an MS4	Technology Development 20/05/2013	20/05/2013	2.4	AW
83	MM Average Speed Enforcement Trial	JJ noted that Trevor Hall (RSS) has already confirmed that the requirements for average speed enforcement to operate with VMSL would have to be covered in a new HO handbook or an extensive update to an existing handbook before HOTA could be taken forwards. The handbook must cover the above configurations (i.e. allow for multiple speed limit signs to be included in a measurement area with checks to ensure that enforcement can only occur if the speed limits are all the same).	Technology Development 20/05/2013	20/05/2013	2.5	JJ
84	MM Average Speed Enforcement Trial	JJ observed that in order to carry out a trial of enforcement the system would have to obtain HOTA. AW suggested that, for a trial, a "half-way" house could be adopted by issuing warning letters instead which would not necessarily mean that the system would have to have HOTA.	Technology Development 20/05/2013	20/05/2013	2.6	AW
85	MM Average Speed Enforcement Trial	As noted above, at this time, both the HADECS 3 contract (with Peek, Redflex and Serco) and the TMT framework (with multiple suppliers, inc Vysionics) could be used to procure enforcement systems.	Technology Development 20/05/2013	20/05/2013	2.7	AW, SN
86	MM Average Speed Enforcement Trial	AW also observed that naming of a trial system does not need to be tied to HADECS.	Technology Development 20/05/2013	20/05/2013	2.8	AW
87	MM Average Speed Enforcement Trial	AW also noted that, when the thinking is further advanced, there could be benefit in holding an industry day with suppliers to discuss the potential approaches to a trial.	Technology Development 20/05/2013	20/05/2013	2.9	AW

Appendix C. Application Overview Matrix

Application Notation for report	Enforcement Behavioural Recording Police support	Mandatory Desirable	Source	Fits architecture	Legal definition exists	Assumed definition for possible enforcement.	Possible approach to technology
Speed	E	M	MM Safety report & Stakeholder Consultation	Y	Y	Exceeding defined speed threshold related to the displayed speed limit	Use EAV to identify the displayed speed limit. Record vehicles with average speed between 2 cameras greater than the speed limit displayed.
Lane closed	E	M	MM Safety report & Stakeholder Consultation	Y	Y	Passing Red X with flashing lanterns or other approved lane closed display by MS4	Use EAV to identify when lane is closed. Record vehicles (still images plus video) passing the lane closed sign.
HS Misuse	E	M	Stakeholder Consultation	Y	N	Sustained used at speed (i.e. above a configurable speed threshold)	Use EAV to identify when hard shoulder is closed and record images vehicles from entry and exit cameras whose average speed exceeds the threshold.
Misuse of ERA	R	M	Stakeholder Consultation	Y	N		
ANPR based tools	R	M	Stakeholder Consultation	Y			
Rapid change of speed	B	D	MM Safety report	Potentially	N		
Close following	E	D	MM Safety report & Stakeholder Consultation	Y	N	Time gap between vehicles less than defined threshold, configurable from 05. second to 3 seconds.	Check time gap at each site. Hence single act of close following or sustained close following may be demonstrated. Should be supported by video of the close following in progress. Optionally additional tracking sensors, such as tracking radar, could be added.
Motorcycles filter through traffic	B	D	MM Safety report	Y	N		
Reversing along slip road	E	D	MM Safety report	Location	Y	Travelling in wrong direction on slip road.	Cameras located at appropriate locations to record video of vehicle travelling on wrong direct. May be necessary to use post mounted direction sensor by the slip road.
Unsafe lane changing	B	D	MM Safety report & Stakeholder Consultation	Y	N		
Entering carriageway unsafely	B	D	MM Safety report	Location	N		
Stopped vehicle detection	R	D	Stakeholder Consultation	Potentially			
Middle lane hogging	B	D	Stakeholder Consultation	Potentially	N		
Worn tyres	VOSA	NA	Stakeholder Consultation	N	Y	Well defined minimum tread depth covering percentage of tyre.	Would require in--road sensors, hence motorway should be avoided. More suited to VOSA based enforcement initiatives.
Driving inappropriately for weather conditions	B	NA	Stakeholder Consultation	Potentially	N		
Illegal vehicles (e.g. over-height, over-weight, wide loads, badly maintained)	VOSA	NA	Stakeholder Consultation	N	Y	Overweight, Overheight defined	Consistent with current VOSA based enforcement initiatives. Aslo weight would require in-road sensors, so not appropriate for motorways. Other applications, such as over-heigth may be possible.
Driving inappropriately after an incident (e.g. slowing down to look, too fast for condition, obstructing emergency services);	B	NA	Stakeholder Consultation	Potentially	N		
Driving whilst using technology (e.g. phone, text, music).	B	NA	Stakeholder Consultation	N	Y	Drivers shall only use phones with handsfree facilities when safe to do so.	Not feassible to get clear view inot vehicle from fixed equipment. Best suited to use recording equipment in equipped Police vehicles.

Possible Link (1 carriageway)
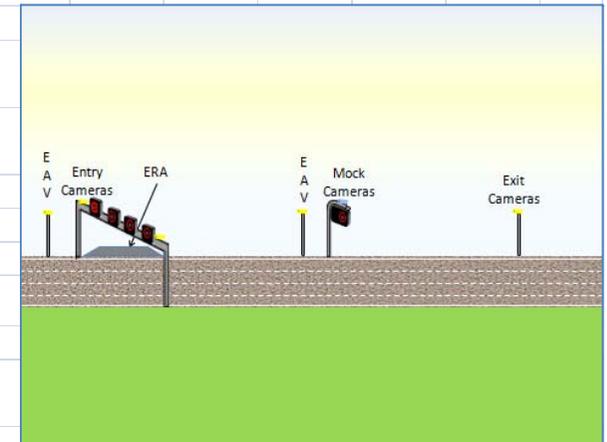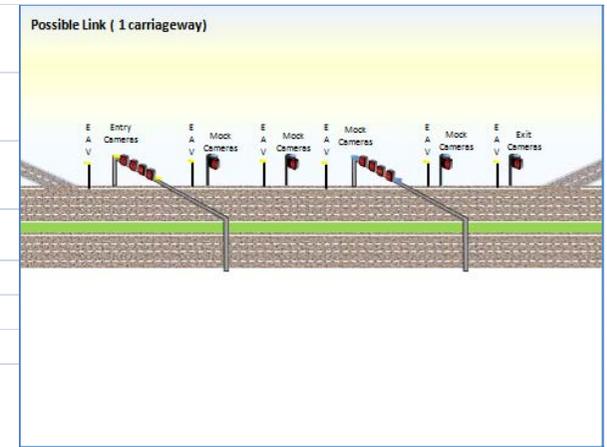
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