Defining Enforcement Technology for Managed Motorways

Approach to Trial and Demonstration of Enforcement Technology with Multifunctional Capability

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Executive summary

The HA's Managed Motorway programme and principles continue to develop. Managed Motorways All Lane Running (MMALR) is expected to provide much needed capacity within manageable costs. The safety and performance of MMALR relies on compliance with the instructions and information on signs and signals as well as the Highway Code. This is clear from the Managed Motorway Safety documents (August 2013).

The HA has identified what enforcement measures might be needed in the future through consultation with critical stakeholders. This report examines one of the main findings of that consultation (i.e. that future enforcement systems should address multiple applications) and proposes an approach to the trial of multifunctional enforcement systems to support Managed Motorways.

Scope of Trial

The proposed trial is intended to provide an opportunity for suppliers to demonstrate their capability to support multiple compliance and enforcement applications. Hence the trial will be based at selected locations equipped with supporting infrastructure to enable the systems to be evaluated.

As the multifunctional systems could be rolled out across Managed Motorways, it is essential that the scope of the trial should include all the stages in the product lifecycle (including installation, commissioning, configuration and site acceptance, demonstration of all declared applications, operation and maintenance).

Mandatory Applications

The trial will provide the opportunity for qualifying suppliers to demonstrate the capability of their multifunctional systems as a common and scalable platform. This will enable the HA to work with Police and other stakeholders to implement more effective and flexible enforcement strategies. As a starting point, suppliers will be required to demonstrate the mandatory (or core) set of applications such as average speed, lane closed, hardshoulder and ERA misuse and ANPR based tools. Investment may be needed in infrastructure to support the trial at several locations, depending on the number of qualifying suppliers.

Success Criteria

The trial will be used to evaluate systems provided by participating suppliers and they should be evaluated against a common set of success criteria, some of which may vary according to the application. If the systems being trialled are to gain Home Office Type Approval (HOTA), full legislation will have to be in place and the success criteria for evaluation will need to be specified. It is highly desirable that the work and systems submitted for the trial go some way to achieving HOTA. Therefore, it is recommended that HA, CAST and RSS agree the definition of "offences" for the trial and the success criteria to be evaluated.

Way forwards

If the systems being trialled are to gain HOTA, full legislation will have to be in place. It is recommended that the following activities will need to be taken forwards to conclusion;

- MM Hazards that need enforcement cameras as part of mitigation confirmed;
- Definition of "offences" for the trial;
- Make definitions into law;
- Create HO CAST handbook;
- Procurement specifications;
- Procurement;
- System development and delivery;
- Trial and evaluation.

Before embarking on a trial, its standing relative to the HA's guidelines will need to be determined. Such a trial could be considered to be a "minor scheme or project", whilst recognising the importance of the outcome to Managed Motorways.

The conclusions and recommendations from this report and the associated Road Map provide a way forward to address and mitigate new and existing hazards to the operation and safety of Managed Motorways where enforcement cameras have been identified as necessary.

1. Introduction

1.1. Background

This project, commissioned as DfT TTEAR framework task 081, is to assist the Highways to identify and capture current and future requirements for enforcement technology to support Managed Motorways (MM), now called Smart Motorways. *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.*

In the last two decades, the Highways Agency has developed a series of successful technologies that have lead to the current generation of Managed Motorways. Up until now, Managed Motorways have required a substantial investment in technology and infrastructure and has had a correspondingly high level of impact on the environment. Now, the Agency is aiming to slim down the provision of technology and infrastructure deployed. This approach will bring the advantages of Managed Motorways to a greater proportion of the motorway and trunk road network.

The HA's Managed Motorway programme and principles continue to develop and there is a need for ongoing flexibility in approach, whilst making best use of the HA's assets and investments. In particular Managed Motorways All Lane Running (MMALR) is expected to release much needed capacity within manageable costs (MMALR is defined in IAN 161/13 (Ref 1). Nonetheless, the safety and performance of MMALR is expected to rely on compliance with the instructions and information presented on the signs and signals as well as the Highway Code. This is clear from the range of Managed Motorway Safety documents that were last updated and published in August 2013, such as the Managed Motorways All Lane Running: Demonstration of meeting safety objective report (Ref 2).

The purposes of this report and the associated study are to address one of the main findings of the study (that future enforcement systems should address multiple applications) and to propose an approach to the trial of multifunctional enforcement systems to support Managed Motorways.

1.2. Scope

Consultation with critical stakeholders identified current and envisaged future compliance issues that could be supported by enforcement technology. This document recommends an approach to trial of enforcement systems with multifunctional capability and includes:

- Scope of the trial
  - Required applications
  - Trial site pre-requirements
  - Success criteria
- Conclusions and Recommendations.

Most existing safety camera and traffic enforcement systems in the UK have Home Office Type Approval (HOTA) for one application. This approach is attractive in the context of ensuring the integrity of the approval system. However, recent discussions with Road Safety Support Ltd. (RSS) and The Home Office's Centre for Applied Science and Technology (CAST) have identified that a single system could be configurable. This would enable one system to provide evidence for enforcement of different offences. The process that would have to be followed to achieve HOTA for multifunctional systems is outside the scope of this report, but it is recommended that this should be clarified through in-depth discussions between the HA, CAST and RSS.

This report proposes the approach for a trial of multifunctional system architecture, which will be configurable and scalable to address applications identified during stakeholder consultations. Also, this report takes account of the hazards identified in recently published Managed Motorways safety documentation (Ref 2). Not all compliance issues can be addressed by roadside systems, so the trial will be based around those applications that are technology-related. Other compliance issues are best supported by Traffic Police, the Vehicle and Operator Services Agency (VOSA) or possibly Highways Agency Traffic Officers (HATOs). Further information on other applications, the technology consultation and roadmap is provided in the report Enforcement Technology Road Map (Ref 3).

2. Approach to Trial

2.1. Scope of Trial

The proposed trial is intended to provide an opportunity for suppliers to demonstrate their capability to provide and support multiple compliance and enforcement applications that have been identified as being necessary to support Managed Motorways, including ALR schemes. Hence the trial will be based at selected locations equipped with supporting infrastructure to enable the systems to be evaluated.

It is essential that the whole lifecycle is taken into account because the multifunctional systems could be rolled out across Managed Motorways. Hence the scope of the trial should assess all the stages in the lifecycle, including:

1. Installation;
2. Commissioning, configuration and site acceptance;
3. Demonstration of all declared applications;
4. Operation;
5. Maintenance.

2.2. Applications

The accompanying Technology Road Map report (Ref 3) identifies and discusses the applications identified during this task including the Technology Consultation. The applications listed below identify the minimum (mandatory) capability in order for systems to be eligible for a trial. Suppliers may add value to their systems by demonstrating additional functionality as identified as desirable applications as well as offering other applications which have not been identified.

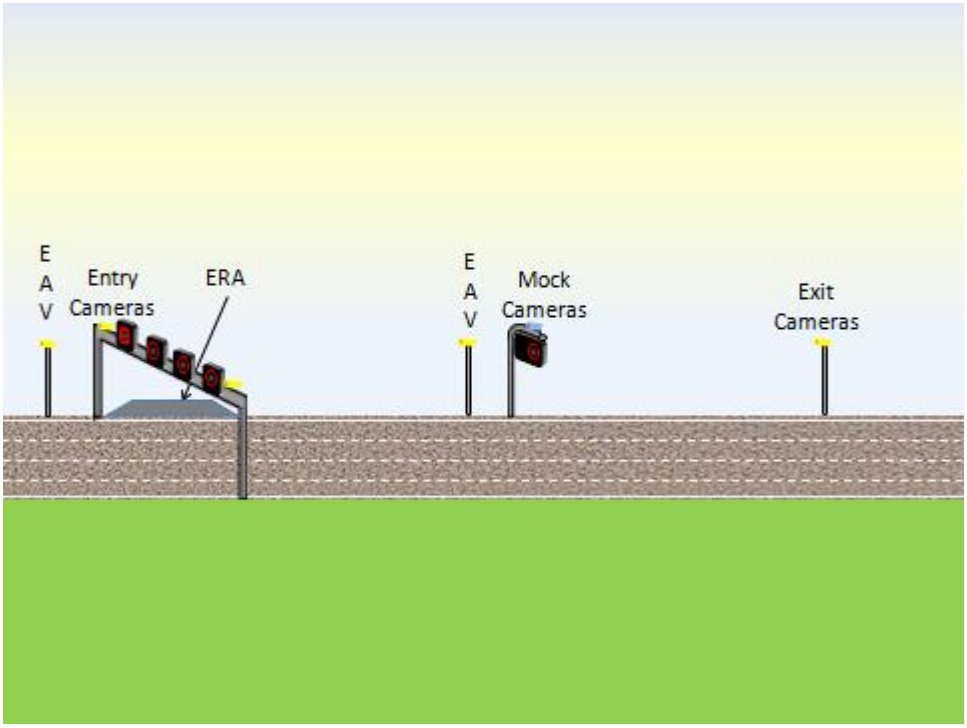
- Mandatory
    - Average speed;
    - Lane closed;
    - HS Misuse;
    - Misuse of ERA;
    - ANPR based tools;
- Desirable (Miscellaneous Managed Motorway hazards mitigation tools);
    - Stopped vehicle detection;
    - Close following;
    - Reversing along slip road;
    - Behavioural tools;
        - Unsafe lane changing;
        - Middle lane hogging;
        - Entering carriageway unsafely;
        - Rapid change of vehicle speed;
        - Motorcycles filter through traffic;
- Other, proposed by the supplier.

2.3. Site Requirements

Figure 2-1below shows the minimum envisaged equipment that should be submitted for a trial site, consisting of:

- **External Aspect Verification (EAV)** cameras mounted on columns to record and automatically identify the display setting when needed, such as Speed limit(s) or Lane Closed;
- **Entry and exit cameras,** which may be mounted on portal gantries, message sign cantilever gantries or dedicated camera columns, depending on the location and application. Also, entry and exit cameras shall be of the same design and shall be configurable to perform either function depending on the required application;
- **Mock equipment,** which contains no active components but has the appearance of live equipment.

Figure 2-1 Minimum Trial Site Configuration



The arrangement in Figure 2-1above is expected to demonstrate all the mandatory applications identified in section 2.2 above. If suppliers offer to demonstrate desirable or other applications (such as reversing up a slip road), then separate locations will have to be considered. Indeed, this particular application may need to be demonstrated on at a test track under more controlled conditions.

2.4. Success Criteria

The trial will be used to evaluate systems provided by participating organisations and they should be evaluated against a common set of success criteria, some of which may vary according to the application.

In order to fully define and measure the performance of a trial, offence 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 and the success criteria for evaluation will need to be specified. Also, it is highly desirable that the work and systems submitted for the trial go some way to supporting HOTA. Therefore it is recommended that HA, CAST and RSS hold in depth discussions to agree:

- Definition of “offences” for the trial;
- Success criteria to be evaluated.

Table 2-1 below provides an initial set of success criteria and Table 2-2 (Page 11) provides initial evidence collection requirements. These provide a basis for discussion and have been compiled using feedback from consultations, experience, and existing HO requirements for similar applications. Also, the focus of Table 2-2 is on those applications identified as mandatory in Section 2.2 above. These will need to be updated to reflect agreements achieved between HA, CAST and RSS.

Table 2-1 Initial success criteria

Feature	Criteria	May Vary according to application.
Number of lanes	4	Y
Evidence collection required.	Refer to Table 2-2.	Y
Presentation	Instation compatibility with Police systems and other enforcement back office systems: • Pentip • VP/FPO • Serco EROS • Startraq	Y
Capture efficiency	Priority to be given to certainty of evidence (i.e. If any doubt, offence should not be recorded). Efficiency to be consistent with current systems. (Data is not openly available, but it is suggested a minimum of 90% capture efficiency should be readily achievable in good conditions and where there is minimal obscuration.)	Y
Throughput	1. Must record 43,200 vehicles per lane per day based on an average headway of 2 seconds. 2. Must record higher flows of up to 4 vehicles per lane per second for intervals up to 1 minute. 3. Any records which cannot be fully completed must be discarded for evidential purposes although they may be retained if statistically useful.	Y
Image quality	Number Plate and Context images: 1. Black and White (B&W)/ monochrome images are acceptable where IR illumination is needed in line with CAST requirements. 2. Colour images are desirable in good daylight conditions. 3. The minimum resolution should comply with HO CAST requirements. 4. Wide dynamic range image capture and storage are desirable at the roadside. 5. Speed Limit display images shall be recorded in colour and with quality consistent with CAST requirements for colour images.	N
Security and data protection	HO data security requirements shall apply. Physical protection, locks and anti-vandalism and anti-tamper measures shall be used. Appearance.	N
Compatibility with Police systems	Pentip VP/FPO Serco EROS Startraq	N

Feature	Criteria	May Vary according to application.
Remote access, control and configuration	Whilst complying with HO requirements, the system must minimise the need for site visits. Safety and security will be improved if access can only be achieved remotely. Availability will also probably improve if faults can be diagnosed and rectified remotely. There must be the capability to view test images without undermining data protection.	N
Appearance	The visible outstation equipment shall be designed to avoid attracting attention and have an external ruggedized appearance to deter tampering. NB Current systems for Mnaged Motorway are painted grey in accordance with HA standards for motorway equipment. This policy may be subject to change.	N
Installation ease	TM arrangements and lane closures for installation must be minimal. Mounting and support arrangements should be designed to minimise disruption during installation and maintenance.	N
Commissioning, set up and test	The time required at the roadside must be minimised.	N
Maintainability	Recommended maintenance intervals (e.g. servicing). Time and complexity. Approach to repair - time on site, remote diagnostics. Repair by replacement. Ease of replacement. Mean Time To Repair (MTTR)	N
Reliability	Evidence of reliability of current designs. Mean Time Between Failures (MTBF) calculation. Experience during trial (e.g. no. of failures, MTTR, MTBF, availability).	N
Reliance on other systems	Are there any interfaces that correct operation relies on? What happens if these interfaces fail? Examples: - Data Communications - Radio clock - GPS - Interface to signs/signals	N
Power consumption to provide mandatory features	Outstation equipment to cover 4 lanes must use <500VA for cable and power supply capacity calculations. Average power consumption for energy cost (General Capacity/Demand Capacity (GC/DC) declaration should be made).	N
Power consumption for all available applications	Outstation equipment to cover 4 lanes must use <500VA for cable and power supply capacity calculations. Average power consumption for energy cost (General Capacity/Demand Capacity (GC/DC) declaration should be made).	N
Compliance with Quality, EMC and environmental standards	All outstation equipment shall comply with Home Office and HA TR1100 requirements covering Quality, EMC and environment.	N

Table 2-2 Initial Evidence Collection Requirements

Application	Evidence collection required.
Average speed	1. Vehicle number plate at entry and exit locations after speed limit display. 2. Context image to show vehicle make and model. 3. Signal/ speed limit display settings and time (or duration) set. 4. Vehicle average speed. 5. Date & Time of entry and exit.
Lane closed	1. Vehicle number plate after lane closed location. 2. Context image to show vehicle make and model. 3. Lane Closed display settings and time (or duration) set.
HS Misuse	1. Vehicle number plate at min 2 locations including the 1 after the HS is closed to show sustained travel along hard shoulder. 2. Context image to show vehicle make and model. 3. Hardshoulder closed display settings, including blank displays and time (or duration) set or blank. NB: This evidence is for sustained misuse at speed. Unlawful stopping can occur for many reasons and appear similar to legitimate stops enforcement is best supported by on road traffic policing.
Misuse of ERA	1.Video of vehicle present in ERA. 2. Vehicle Number plate. 3. Entry date & time. 4. Exit date & time or time of 5. HATO/Police intervention.
ANPR based tools	1. List of recognised number plates. 2. Rules set up to enable search for or exclusion of specific vehicles.

3. Conclusions & Recommendations

During the course of this task, the focus shifted from specific consideration of average speed enforcement to a broader look at enforcement applications to support Managed Motorways. One of the important findings of the study is that MMALR could benefit from a range of enforcement measures and that deployment of multifunctional systems might well be less costly than piecemeal introduction of different applications as they arise. Hence this report recommends;

> ***The approach for the trial of multifunctional systems should be pursued as described in Chapter 2.***

The process that would have to be followed to achieve HOTA of multifunctional systems is not within the scope of this report but it is recommended that;

> ***In depth discussions should progress between the HA, CAST and RSS, to clarify the process.***

This will enable a range of documents and specifications to be developed. So it is recommended that;

> ***The following documents should be prepared:***
>
> - ***Specification for the trial of multifunctional systems (based on this document)***
> - ***HO CAST Handbooks for each enforcement application***
> - ***Interpretation of the HOTA process for multifunctional systems***
> - ***Legal definitions for each enforcement application***
> - ***Agreements for data sharing the monitoring and ANPR based systems between Police and HA.***

Motorways are classed as “Special Roads” and Section 17 of the Road Traffic Regulations 1984 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 TROs) specifically for motorways. Therefore, there is an opportunity to put in place the legal principles to support otherwise undefined offences. For example, close following (tailgating) does not currently have a clear definition that is measureable.

In order to fully define and measure the performance of a trial, offence definitions are required. Also, if the systems being trialled are to gain HOTA, full legislation will have to be in place. it is recommended that;

> ***The following activities should be taken forwards to conclusion;***
>
> - ***MM Hazards that need enforcement cameras as part of mitigation confirmed***
> - ***Definition of “offences” for the trial***
> - ***Make definitions into law***
> - ***Create HO CAST handbook***
> - ***Procurement specifications***
> - ***Procurement***
> - ***System development and delivery***
> - ***Trial and evaluation***

Before embarking on a trial, it is recommended that;

> **The trial’s standing relative to the HA Guidelines should be determined, recognising the importance of the outcome to Managed Motorways.**

The conclusions and recommendations from this report and the associated Road Map (Ref 3) provide a way forward to address and mitigate new and existing hazards to the operation and safety of Managed Motorways where enforcement cameras have been identified as necessary.

4. References

Ref 1 Highways Agency, Interim Advice Note 161/13, Managed Motorways – All Lane Running, August 2013.

Ref 2 Highways Agency, Managed motorways all lane running demonstration of meeting safety objective report, August 2013

Ref 3 Atkins, Defining Enforcement Technology for Managed Motorways Enforcement Technology Road Map, December 2013

Ref 4 Highways Agency, “Guide for the design, management and delivery of pilots and trials on the Highways Agency network”, issue 3, April 2012

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