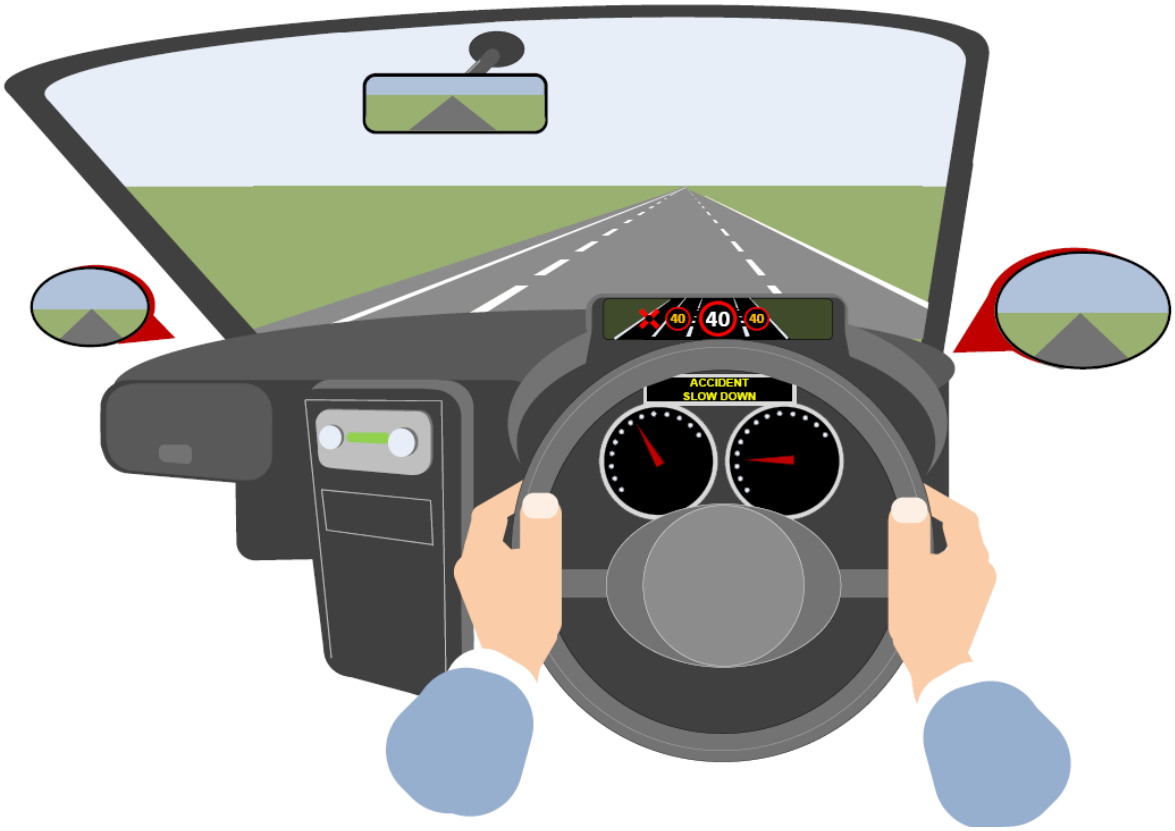
HIGHWAYS AGENCY

The journey ahead:

Delivering Managed Motorway information directly to in-vehicle devices

Summary report



Owen Ardill
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An Executive Agency of the Department for Transport

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Revision Schedule

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Executive summary

The mandate

In December 2009 the Highways Agency (Network Services) commissioned a study into the implications of the use of current and future in-vehicle travel information devices on Controlled and Managed sections of the motorway network. The study aimed to discover and assess the challenges faced by the Highways Agency and to propose a suitable action plan to ensure continued achievement of the Highways Agency's core objectives, whilst embracing the market driven shift to in-vehicle driver information provision.

The challenge

There are two important reasons why this study was required and why its recommendations must be considered.

1. Despite emerging efforts from both the Agency and Industry, there is currently a conflict between information provided by commercially available in-vehicle devices and the roadside infrastructure on Managed Motorway sections. Incorrect speed limit and lane configuration display on in-vehicle devices can lead to driver confusion and have potential safety implications. This is illustrated on page 3 of this report.
2. The Highways Agency can unlock vast cost savings in the short to medium term by taking advantage of existing and developing in-vehicle devices to reduce or ultimately remove the reliance on roadside infrastructure. This will reduce capital and ongoing costs as well delivering environmental sustainability benefits.

Short-term recommendations

As in-vehicle devices continue to be rolled out by the commercial providers, the challenges above will become progressively harder to resolve as systems diverge. In order to address this, the following short term action plan is recommended.

- Confirm and implement changes to traffic management systems, as defined by the functional specification output by this study. This will ensure that these systems are capable of interfacing with future in-vehicle devices.
- Continue to engage with the wider ITS community, DfT and European Commission to develop an implementation strategy, including assessment of possible legislative changes.
- Continue to engage with in-vehicle device suppliers to clarify interface requirements and address the human factors considerations raised within this study, following previous initiatives where industry sought access to HA data

If the Highways Agency wishes to manage traffic on its network it needs to provide accurate tactical travel information as it does at present via roadside signage. The responsibility for the development and enhancement of in-vehicle devices will remain with the private sector providers.

Failure of the Highways Agency to act now will result in more and more cases of conflicting information being provided to drivers by third parties, a situation industry also wants to avoid. It is essential that the Highways Agency puts in place systems, policies and processes to ensure that it is a position to realise the benefits which become available as technology advances.

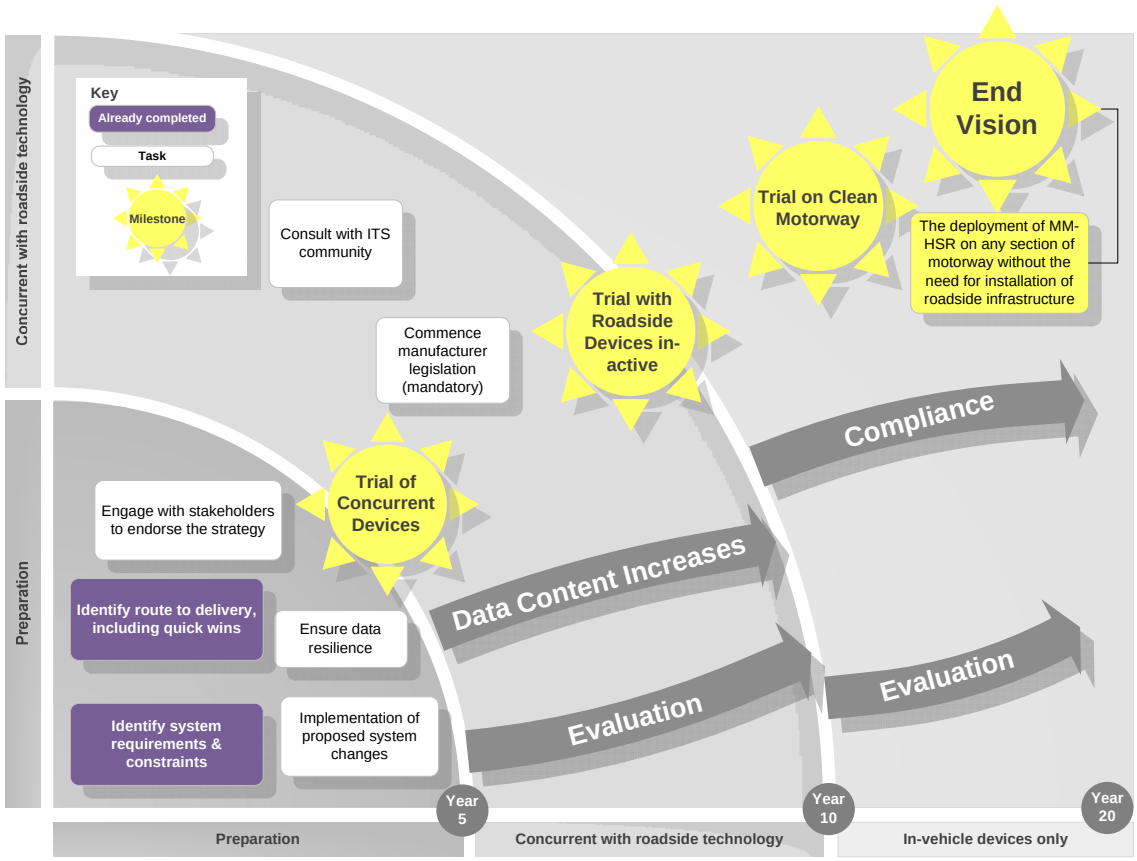
The end vision and 20 year plan

The analysis carried out within this study focussed on achieving the following objective:

"The deployment of Managed Motorways, including Dynamic Hard Shoulder Running, on any section of motorway without the need for the installation of roadside infrastructure"

It is recognised that this is a long term objective; for this reason the analysis has focussed on the activities that will deliver benefits to the Highways Agency in the short to medium term whilst moving in the correct strategic direction.

The diagram below illustrates the proposed route to the end objective, with tasks that have been completed as part of this study coloured in purple. There are 3 distinct phases, each one leading to key milestones. Maximum benefit is realised at each milestone through the implementation of low risk quick wins.



Quick wins

The following quick wins have been identified which can begin to deliver benefit and address the challenges identified with minimal technical or policy development:

- Provide very basic information to providers of current in-vehicle devices to alert the driver when they are entering a Managed Motorway section and the status of the hard shoulder. This would enable in-vehicle device manufacturers to vary information provided to drivers when entering a Managed Motorway section. This could be done very quickly using existing RDS-TMC receivers
- Early stakeholder engagement with in-vehicle device manufacturers and continued discussions with Service Providers such as Trafficmaster and ITIS,to gain an understanding of their development plans and share information relating to the dynamic nature of Managed Motorway information provision. This will support the development of an agreed strategic direction to provide the best end service to the travelling public.
- Early deployment of tactical travel information to freight and public transport vehicles. This would facilitate a system trial in a more controlled environment and therefore with lower risk. It would also support the initiative to implement HOV lanes on some sections of motorway with minimal roadside infrastructure.

Outputs from this study

The remainder of this report summarises the outputs of the study, which has comprised the following key activities.

- Develop a clear understanding of, and document, the objectives and requirements of providing Managed Motorway information to the traveller;
- Asses how the provision of this information would be affected by the use of in-vehicle devices, as opposed to roadside infrastructure;
- Development of draft functional specifications for modifications required to the existing traffic system architecture to facilitate future requirements. A specific focus was placed on any quick wins that could be achieved.

The detailed output of each element can be found in the appended “Analysis Report”.

Table of contents

Table of figures

1 Introduction

This document summarises the key findings of the Managed Motorways In-Vehicle Data Requirements Research Project, commissioned by the Highways Agency and conducted by Scott Wilson Ltd.

The study identifies the requirements that will facilitate the future integration of in-vehicle devices into the ITS infrastructure. The starting point for this study is a vision of a system that will provide drivers with the same level of tactical information that is provided by the current array of roadside technologies. This includes not only messages, but also lane specific speed restrictions and diversions for traffic management, including dynamic use of the hard shoulder on Managed Motorways.

This document focuses on the end vision and the steps that are required to realise it. This report does not set out all points of the analysis but comprehensive detail can be found within the accompanying Analysis Report which includes:

- A detailed analysis of the current data requirements for signal and message sign settings on Managed Motorways;
- A top-level functional specification for the in-vehicle device, describing requirements for the transmission system;
- Details of the necessary changes to the Highways Agency's traffic management system architecture to facilitate future in-vehicle devices.

2 The need for action

2.1 Introduction

Due to the futuristic nature of the concept of the complete removal of roadside infrastructure, the reader may assume that this study is addressing only long term issues. In fact, the mandate for commissioning this study was driven by the very real challenges faced by the Highways Agency in the short and medium term. i.e. starting from now.

Through the course of the analysis many individual and specific challenges have been identified, these are fully documented in the Analysis Report. For the purpose of illustrating the need for action the two primary challenges faced by the Highways Agency have been focussed on:

- The need by the Agency and Industry to prevent the conflict of information between roadside infrastructure and current in-vehicle information systems;
- The need to minimise capital expenditure whilst continuing to deliver the capacity and safety benefits provided by Managed Motorways.

The sections below illustrate these points in more detail.

2.2 Context

The Highways Agency is not alone in recognising the need to be ready to adopt and interface with the future in-vehicle information devices. The European Commission (EC) has developed an ITS Action Plan[1] that sets out a number of targeted measures for the deployment of Intelligent Transport Systems in road transport. The Action Plan invites Member States to accelerate their work to define functional specifications for trans-European applications, with one objective being “effective integration of the vehicle into transport infrastructure”. The detailed analysis that has been undertaken in this study partly addresses this requirement. To fully meet the EC’s objective the momentum must be maintained.

The rail sector seems to be relatively advanced in their pursuit to remove line-side signals and utilise in-cab signalling technology. The European Railway Traffic Management System[2] is currently being deployed across Europe, it provides common safety and communication systems. The West Coast Mainline has already adopted some of these features.

[1] Council conclusions on the commission communication, “Action Plan for the Deployment of Intelligent Transport Systems in Europe, Council of the European Union.
[2] http://www.ertms.com/

2.3 Conflict of information provision to the driver

The Highways Agency does not currently have a mechanism in place to publish tactical travel information other than via roadside infrastructure. As a result of this, in-vehicle devices display information that does not correspond with traffic conditions on Managed Motorway sections. Incorrect information on speed limit and lane geometry is routinely being conveyed to the driver. Some service providers have already recognised this and on several occasions sought a source of rapidly published and accurate information from the Agency.

The immediate implications, as more and more companies provide lane by lane displays and current speed restrictions, are that more drivers are miss-informed of Managed Motorway conditions. This will effectively de-value the significant investment the Highways Agency has made in roadside infrastructure. An example of this current conflict is shown in Figure 2-1.

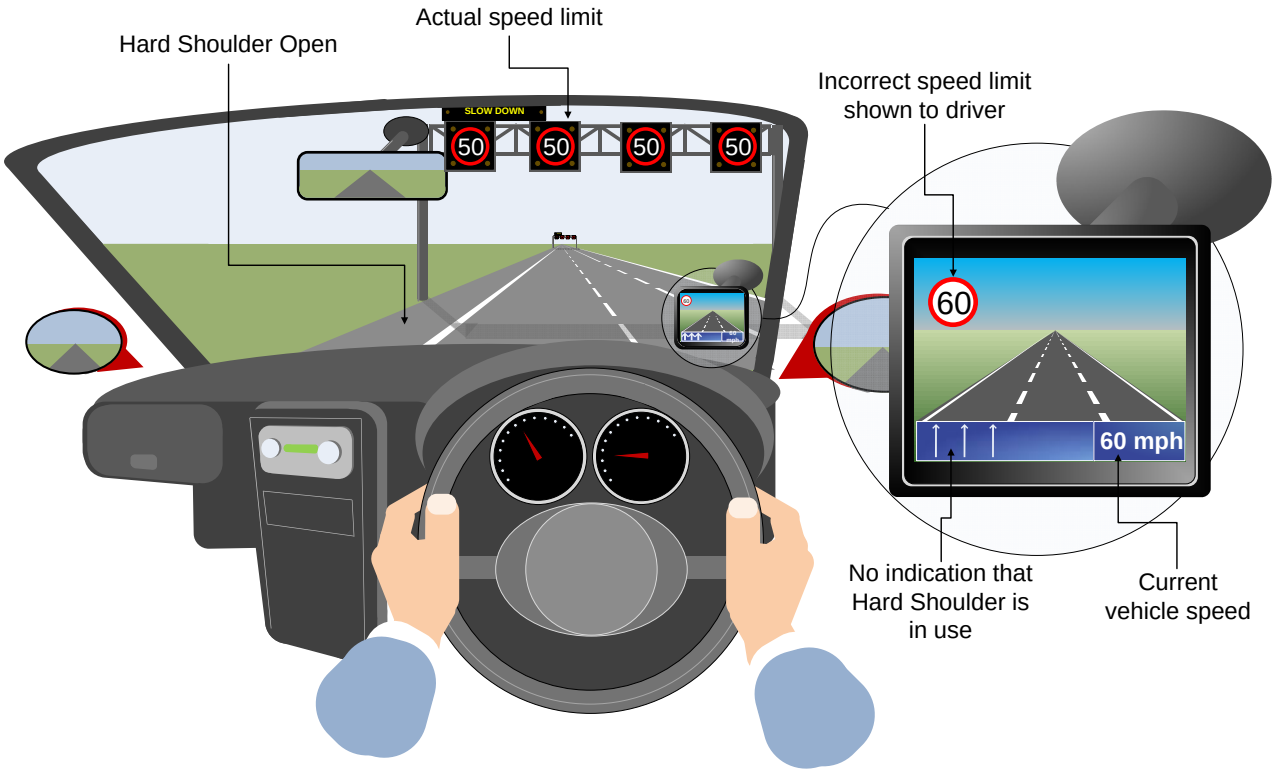


Figure 2-1: Current conflict between roadside technology and in-vehicle devices

Conflicting messages are likely to result in driver confusion, which could lead to frustration and a distrust of in-vehicle information or roadside infrastructure as well as safety implications. The need for consistency is shared.

The Analysis Report provides a number of these specific examples and details options for ensuring that they do not occur. This has informed the development of the functional specification which must allow for a system which can deal with each traffic management scenario, whilst presenting accurate and timely information to the driver.

2.4 The need to maximise benefit from capital spend

The Highways Agency can unlock vast cost savings in the short to medium term by utilising in-vehicle devices to reduce or ultimately remove the reliance on roadside infrastructure. This will reduce capital and ongoing costs as well as delivering environmental sustainability benefits.

Short term cost savings can be achieved by relaxing the current inter-visibility requirements which currently drive close gantry spacing. The use of in-vehicle devices can add to the safety case and potentially result in gantries being spaced further apart.

Longer term benefits would result from the ability of the Highways Agency to realise the safety and capacity improvements offered by Managed Motorways on sections of road, without the need for installation of any roadside infrastructure.

To highlight the potential cost savings, the cost per km of infrastructure construction based on the M42 pilot scheme[3] (£3.2m /km) has been applied to the number of committed lane kilometres that will operate under a Managed Motorway regime. There is a funding commitment to provide 340 lane miles[4] (547 lane kilometres) of HSR, all of which are scheduled to have commenced construction by 2015.

The cost specifically relating to this infrastructure construction will be approximately £1.7 billion. Using the current Managed Motorway programme as an example, the potential cost savings on infrastructure construction alone could be substantial. In addition, there would be maintenance cost savings and environmental benefits associated with this initiative.

[3] Advanced motorway signalling and traffic management feasibility study, DfT, March 2008
[4] Britain's Transport Infrastructure Motorways and Major Trunk Roads

3 Deriving a view of the end system

Overall objective: In-vehicle technologies should complement roadside technologies until such time that roadside infrastructure is no longer required.

The in-vehicle device should provide drivers with the same level of tactical and strategic information that is provided by the current array of roadside technology.

This provides not only for messages, but also lane specific restrictions and diversions for traffic management, including dynamic use of the hard shoulder on Managed Motorways.

Ultimately, the vision is of a system where roadside technologies and in-vehicle technologies can complement one another and be interchangeable so that in-vehicle devices could provide a stand alone alternative to roadside devices along sections of the motorway network.

A top-level functional specification and interface specification has been produced that describes the necessary changes to the Highways Agency Traffic Management System (HATMS) in order to facilitate the provision of data to in-vehicle devices.

Figure 3-1 illustrates how a HATMS integrated in-vehicle device may look.

Figure 3-1: Dash top device

4 Approach to delivery of the end vision

4.1 Introduction

Figure 4-1 illustrates the proposed route to the end objective with tasks that have been completed as part of this study coloured in purple. As can be seen there are 3 distinct phases, each one leading to key milestones. Maximum benefit is realised at each milestone through the implementation of low risk quick wins.

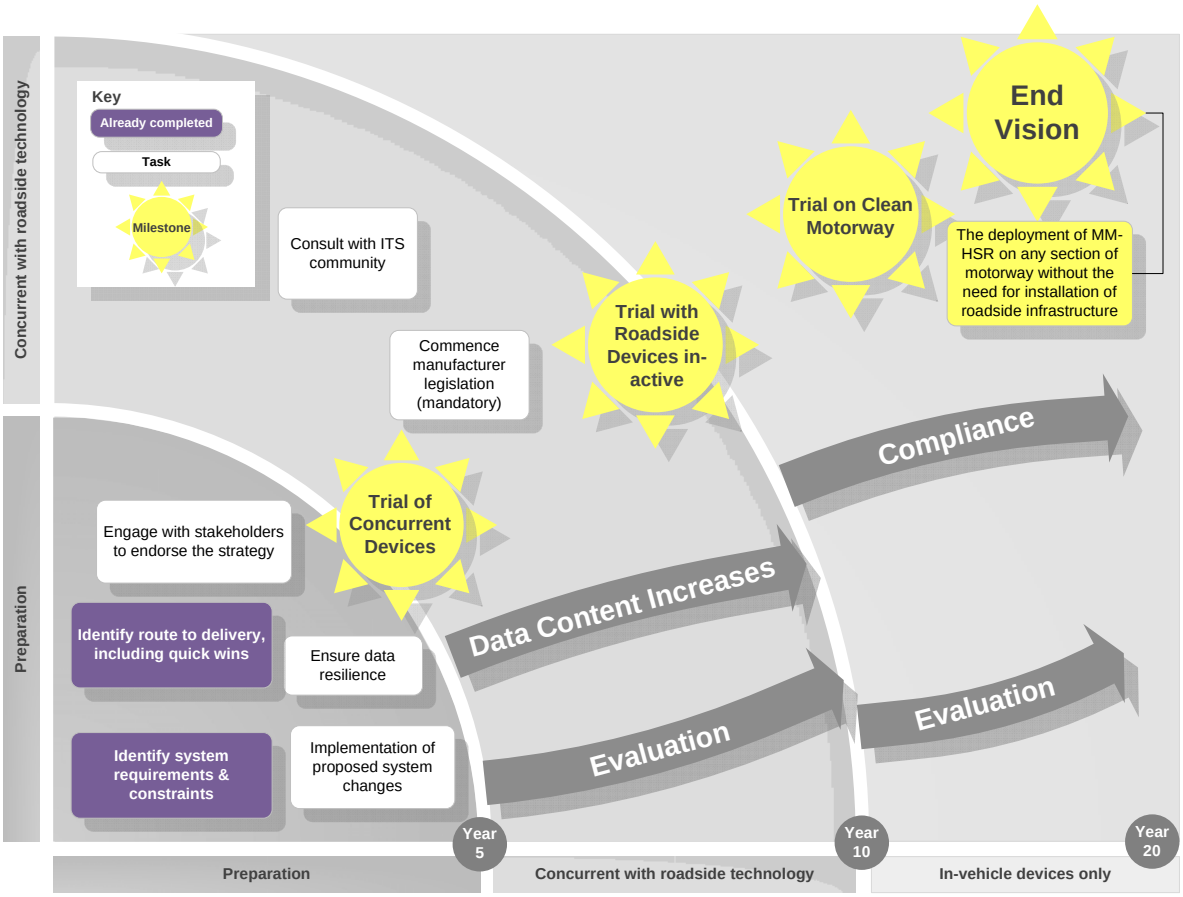


Figure 4-1: Transition map for the implementation of in-vehicle devices

Each of the 3 phases (Preparation, Concurrent and In-vehicle only) is described in more detail in the remainder of this section with details of the tasks which have been completed.

4.2 Preparation phase

There are a number of preparation/enablement tasks that are necessary to achieve the interim objective of trialling in-vehicle devices concurrently with roadside devices. These tasks have been highlighted in Figure 4-1.

There are additional tasks such as stakeholder engagement, addressing human factors considerations raised in the Analysis Report and agreeing a strategy for legislation that are necessary before concurrent operation can be implemented.

A period of approximately five years is a reasonable timescale to have completed the tasks in the preparation phase, and so by 2015/16 trialling of concurrent operation could commence. This relatively short time period will help ensure work is accelerated to meet EC ITS objectives. The sections below provide a summary of the analysis that has been undertaken and highlights considerations for future analysis.

However, there are also a number of quick wins. Current RDS-TMC receivers could show drivers the current status of a controlled motorway lane, and for example the presence of winter maintenance vehicles, well outside the scheme itself. All that is needed is a source of timely and accurate data in a standard format for service providers to add to their current feeds.

4.2.1 Tasks completed within this study

The following tasks have been completed within the context of this study, with comprehensive analysis provided in the Analysis Report:

- **Identify changes to HATMS architecture**;
- **Identify data requirements for both signal and message setting data**;
- **Define constraints on the system**- A series of constraints which will be imposed by existing safety requirements and available data content have been identified. These will be critical to the successful development of in-vehicle devices and their integration with Highways Agency systems.
- **Define top level inter-face specification for HATMS/in-vehicle device inter-working**.
- **Identify quick wins** - A strategic approach has been adopted for this study that has focused on the changes required to implement the end vision, rather than making ‘bolt-on’ changes to systems. Nevertheless, a number of ‘quick wins’ that would be relatively simple to implement and cost effective have been considered and are described below:

- Provide very basic information to in-vehicle devices eg existing RDS-TMC sat navs to alert the driver when they are entering a Managed Motorway section and the status of the hard shoulder. This would enable in-vehicle device manufacturers to vary information provided to drivers when entering a Managed Motorway section.
- Continued stakeholder engagement with in-vehicle device manufacturers to gain an understanding of their development plans and share information relating to the dynamic nature of Managed Motorway information provision. This will support the development of an agreed strategic direction to provide the best end service to the travelling public.
- Early deployment of tactical travel information to freight and public transport vehicles. This would facilitate a system trial in a more controlled environment and therefore with lower risk. It would also support the initiative to implement HOV lanes on some sections of motorway with minimal roadside infrastructure

4.2.2 Tasks to be completed

The following set of tasks needs to be undertaken within the preparation phase to enable concurrent operation of the in-vehicle device and roadside device:

- **Engage with stakeholders** – Section 4.5 lists stakeholders that should be consulted with now and in the near future.
- **Define data availability** – Data availability figures will need to be defined so that end systems are designed to deal with potential loss of service. In the same way that roadside infrastructure fails to a safe mode on loss of power, in-vehicle devices should do the same.
- **Develop detailed implementation strategy** - Legal specialist input is required to advise the Highways Agency of the legislative consequences of in-vehicle devices. The sort of issues that will need to be addressed include:
  - Speed enforcement – will this be monitored via the in-vehicle device or will average speed cameras be necessary?
  - Provision of data to third parties – what stipulations will the data come with, i.e. how must the data be displayed?
  - Data resilience – what are the legal consequences if the in-vehicle device fails?
- **Completion of human factor analysis** – It will be necessary to appoint specialists to complete analysis of the various Human Factors Considerations that have been raised in the analysis report. Preliminary advice from specialists has been reported on in the Analysis Report together with a plan for analysing and modelling Human Factors.

4.3 Concurrent phase

The concurrent phase is the period during which the roadside devices will continue to function as normal while data is being sent to in-vehicle devices concurrently. During this phase, the information contained on roadside devices will have primacy over the data displayed on the in-vehicle device.

During this period, currently estimated to be approximately 10 years, a number of processes need to be undertaken to meet the secondary objective of trialling the system with roadside devices switched off. These processes are:

- **ITS community consultation** – there will be a need to continue to consult with the wider ITS community and European Commission to fit in with the trans-European in-vehicle strategy;
- **Increase data content** – to enable in-vehicle device manufacturers to convey information to drivers about road traffic accidents and various restrictions imposed by traffic management measures;
- **Evaluation** – there will be a need to continuously monitor and evaluate the in-vehicle system. Features to monitor include compliance, safety, traffic flow, journey times and environmental considerations; and
- **Manufacturer legislation** – as the in-vehicle system develops through this phase discussions with manufacturers needs to be continued.

4.4 In-vehicle device only phase

Ultimately the end vision will be realised when Managed Motorways on a ‘clean’ section of motorway can be implemented relatively quickly and without the capital investment of installing the vast array of roadside infrastructure currently necessary.

One of the key considerations when developing the functional specification was the possible need to move directly to the in-vehicle device only phase, bypass in the concurrent phase. With this in mind the specification does not introduce concepts or requirements which preclude this from happening.

4.5 Stakeholder engagement

Several stakeholders have already approached the HA to suggest ways of making information more consistent, but until now, data simply cannot be provided to them. As part of this study, high level requirements for stakeholder engagement have been set out. There is a need for internal consultation within the Highways Agency to commence now, including the following departments; Network Delivery and Development (NDD), Network Services (NetServe) and Traffic Management Directorate (TMD). Figure 4-2 shows the various organisations and the approximate sequence for engagement.

When the Highways Agency has developed a clear internal action plan, the wider ITS community would need to be consulted with to take into account other agendas. Indicative time-scales of between 2011 and 2013 have been provided in Figure 4-2.

Other down stream organisations have been identified and will need to be engaged within the indicative time scales shown below.

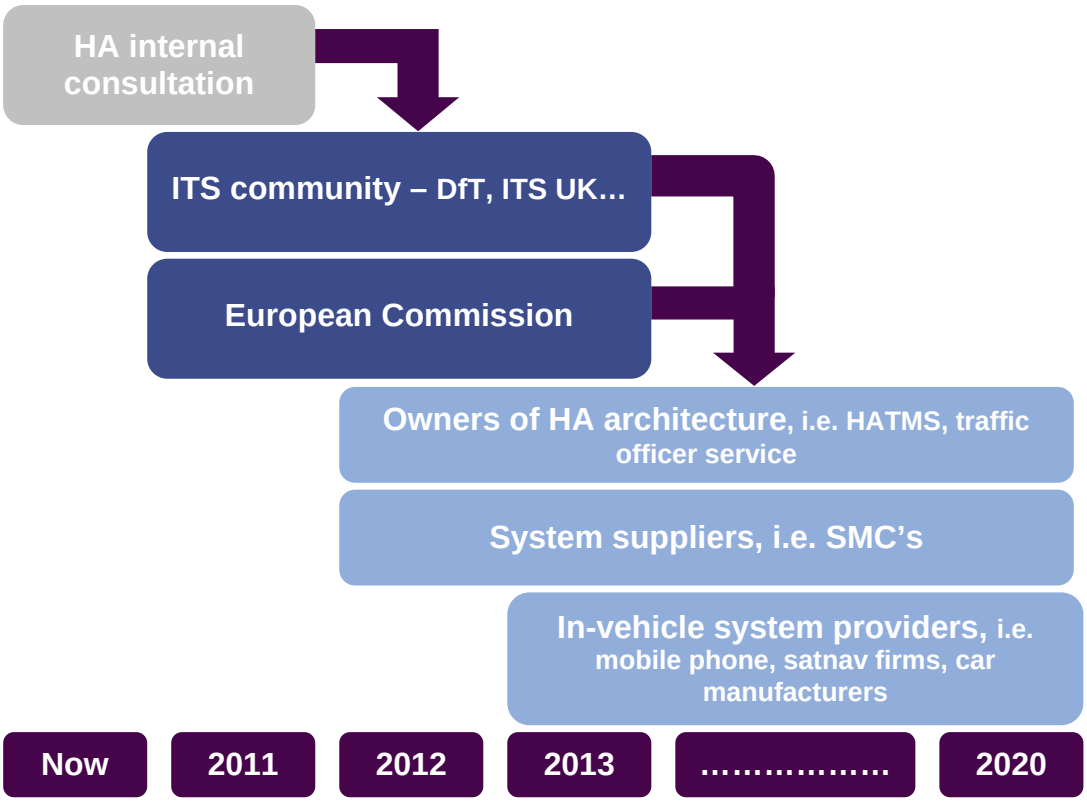


Figure 4-2: Stakeholder engagement flow diagram

5 Short, medium & long term benefits

This section describes the benefits associated with pursuing the recommended approach. Benefits which can be realised in the short term are focussed on but a strategic view to achieving maximum long term benefits has been adopted to prevent abortive work.

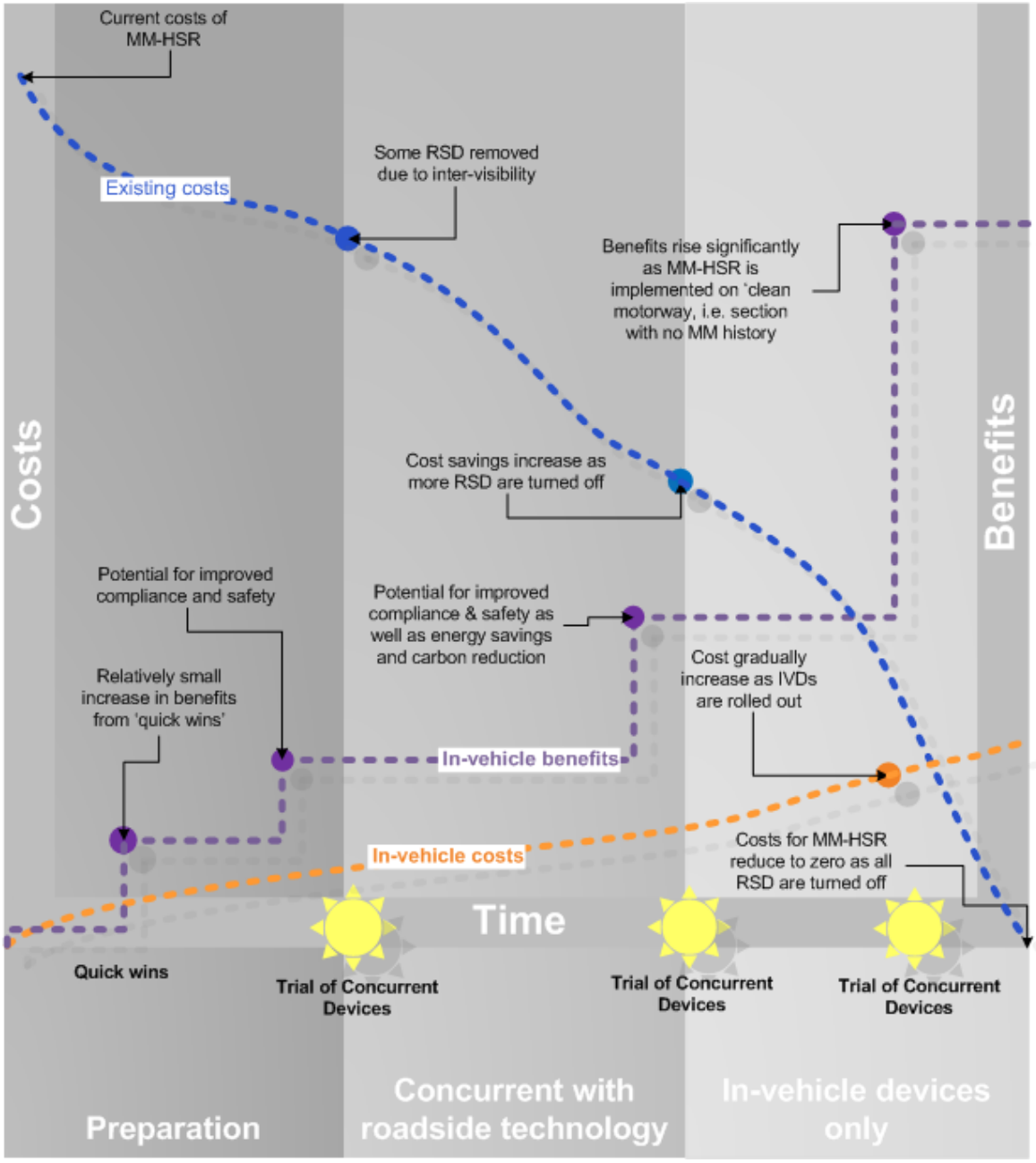


Figure 5-1: Indicative costs and benefits by key milestone

Figure 5-1 plots the reduction of costs associated with Managed Motorways controlled by roadside devices and the indicative rise in costs associated with providing Managed Motorway information to in-vehicle devices. The sum of these costs is likely to result in a significant net reduction in investment.

The step changes in benefits are due to the following features of in-vehicle devices:

- **Facilitate additional Managed Motorway sections** - Perhaps the most significant benefit that in-vehicle devices will provide is the ability for additional sections of motorway to be incorporated into Managed Motorway schemes relatively quickly. As demand across the motorway network changes in the future, the system has the flexibility to adapt to provide additional highway capacity. It should be noted that certain pre-requisites will remain, such as the need to provide Emergency Refuge Areas and strengthening of the hard shoulder.
- **Inter-visibility and reduction of roadside infrastructure** – Inter-visibility requirements are responsible for the close spacing of gantries on Managed Motorway sections. The ability to provide drivers with another source of information will enable these requirements to be relaxed. This will result in reduction in the number of gantries in the short term with a view to ultimately removing them altogether.
- **Financial** - It has been estimated (see section 2.4) that the infrastructure construction costs associated with the current programme of Managed Motorways is £1.7 billion. These are costs that could be avoided with an in-vehicle method of displaying traffic information. Not having to provide roadside devices will provide significant cost savings as the responsibilities of the TechMAC are reduced considerably. Furthermore, cost savings will be made by not having to procure roadside devices. There is an opportunity for the Highways Agency to transfer the cost and responsibility of roadside infrastructure to the providers of in-vehicle devices. There is work to be undertaken that is not within the scope of this study to define more closely the costs associated with in-vehicle devices. Notwithstanding this, the difference in construction cost alone is likely to be significant.
- **Visual intrusion** - In areas of outstanding natural beauty the case for implementing Managed Motorways will be challenging. An in-vehicle system provides the opportunity to operate Managed Motorways through these sensitive areas without the need for the associated roadside structures.
- **Energy savings** - The energy requirements for the provision of information to in-vehicle devices is likely to be significantly less than what is currently required to illuminate and maintain the extensive array of roadside devices.
- **Traffic management** - The in-vehicle device could facilitate other uses apart from managing traffic during the dynamic use of the hard shoulder. The changes would allow for a truly mobile system that could be deployed anywhere and at anytime. For example, the emergency services via the RCC could make use of the system to manage traffic after an incident.

- **Dedicated Lanes** - The in-vehicle device could also be used to indicate lane specific uses, for example, bus lanes, car share lanes and where weight restrictions apply.
- **Safety, compliance and vehicle emissions** - The monitoring and evaluation studies[5] that have been undertaken for the M42 pilot scheme have demonstrated that Managed Motorways have a positive effect in terms of improving compliance, reducing accidents and vehicle emissions. There is every possibility of indirectly improving safety, compliance and reducing vehicle emissions as more sections of Managed Motorways are introduced. For example, during adverse weather conditions visibility is often reduced. An in-vehicle device completely mitigates this impact as illustrated in Figure 5-2.

Figure 5-2: Rainy day scenario

[5] ATM monitoring and Evaluation 4-Lane Variable Mandatory Speed Limits 12 month report, June 2008.

6 Summary

This project has provided a comprehensive analysis of how the requirements of the current system would need to be changed when applied to future in-vehicle data provision of Managed Motorway information. The analysis has shown that such a system is technically achievable. This study has also proposed a suitable action plan to ensure that the Highways Agency's core objectives continue to be met.

There are two important reasons why this study was required and why its recommendations must be considered.

1. There is currently a conflict between information provided by commercially available in-vehicle devices and the roadside infrastructure on Managed Motorway sections. Incorrect speed limit and lane configuration display on in-vehicle devices can lead to driver confusion and have potential safety implications. This is illustrated on page 3 of this report. In vehicle service providers have already suggested solutions to the Agency which we are currently unable to support as data is not available.
2. The Highways Agency can unlock vast cost savings in the short to medium term by taking advantage of in-vehicle devices to reduce or ultimately remove the reliance on roadside infrastructure. This will reduce capital and ongoing costs as well delivering environmental sustainability benefits.

As in-vehicle devices continue to be rolled out by the commercial providers, the challenges above will become progressively harder to resolve as systems diverge. In order to address this, the following short term action plan is recommended.

- Confirm and implement changes to traffic management systems, as defined by the functional specification output by this study. This will ensure that these systems are capable of interfacing with future in-vehicle devices.
- Continue to engage with the wider ITS community and European Commission to develop an implementation strategy, including assessment of possible legislative changes.
- Continue to engage with in-vehicle device suppliers and service providers to clarify interface requirements and address the human factors considerations raised within this study.

If the Highways Agency wishes to manage traffic on its network it needs to provide accurate tactical travel information as it does at present via roadside signage. The responsibility for the development and enhancement of in-vehicle devices will remain with the private sector providers.

Failure of the Highways Agency to act now will result in more and more cases of conflicting information being provided to drivers by third parties. It is essential that the Highways Agency puts in place systems, policies and processes to ensure that it is a position to realise the benefits which become available as technology advances.

The analysis that has been undertaken within this study has focused on achieving the end vision – The deployment of Managed Motorways, including Dynamic Hard Shoulder Running, on any section of motorway without the need for the installation of roadside infrastructure. An action plan has been developed that identifies distinct phases and milestones en route to its delivery.

The in-vehicle system will provide a number of benefits ranging from reducing the environmental impact, i.e. energy savings and visual intrusion to facilitating future traffic management initiatives such as HOV lanes.