# Core European ITS Services and Actions

## Guideline for the Deployment of Hard Shoulder Running

<table>
<thead>
<tr>
<th>Ref.</th>
<th>TMS-DG04</th>
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<tbody>
<tr>
<td>Date</td>
<td>12th December 2009</td>
</tr>
<tr>
<td>Version</td>
<td>4.0</td>
</tr>
<tr>
<td>Responsible</td>
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</tr>
</tbody>
</table>

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GUIDELINE FOR THE DEPLOYMENT OF HARD SHOULDER RUNNING [TMS-DG04]

**SERVICE DEFINITION**

Hard shoulder running enables dynamic use of hard shoulders with the aim to increase road capacity. Hard shoulder running could be considered similar to the creation of an extra lane.

Hard shoulder running is usually triggered by traffic demand or at fixed times, and applied for bottlenecks or problem stretches with recurrent -but not constant- lack of capacity.

**SERVICE OBJECTIVES**

The aim of hard shoulder running is a capacity increase on a section of the road network to avoid (heavy) congestion and to reduce the probability of incidents.

**SERVICE LEVEL DEFINITION**

<table>
<thead>
<tr>
<th>Element of Hard Shoulder Running</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitoring</td>
<td>Manual through traffic officers and/or police</td>
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<td>Automatic through cameras, loops, sensors</td>
</tr>
<tr>
<td>Safeguarding</td>
<td>Physical</td>
<td>Physical and through cameras</td>
<td>Physical and through cameras + Automatic detection</td>
</tr>
<tr>
<td>Dynamic information</td>
<td>Fixed</td>
<td>Dynamic prism</td>
<td>VMS</td>
</tr>
<tr>
<td>Activation and de-activation</td>
<td>Manual</td>
<td>Manual</td>
<td>Manual and based on decision support systems</td>
</tr>
</tbody>
</table>

**Enforcement**

- Physical and periodical
- Automatic
- Automatic

Note: “Enforcement” has to be considered as a complementary criteria in the identification of service level, depending on national or regional policies and local characteristics of the service implementation.

The “enforcement” criteria could not be considered as critical or mandatory while achieving a level of service. Therefore, binding obligations concerning the implementation of enforcement could not be imposed on EasyWay partners.

**EUROPEAN DIMENSION**

Major purpose of Hard shoulder running implementation is to instruct road users in a safe and unambiguous way. A common approach for further deployments should be developed on:

- Harmonised unambiguous behaviour instructions dedicated to road users,
- Safety protocols for scenarios and deployments of hard shoulder running.
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1. General framework

This guideline describes the traffic management measure, hard shoulder running. Hard shoulder running is strongly linked to Dynamic Lane Management. Due to the specific characteristics of a hard shoulder (i.e. emergency services, car trouble) a separate guideline was considered a valuable contribution to the EasyWay traffic management guidelines.

1.1. General service description and objectives, including co-modality

In the past decades traffic density on European roads has increased to such an extent that it proves difficult or unwise for road operators to adjust the capacity of some parts of the network to its demand. The following questions are raised:

- Is it necessary?
  Sometimes extra capacity is only needed for 2 or 3 hours a day.
- Will it benefit traffic flow?
  Studies show that an increase in capacity only has a limited impact on congestion. Extra road attracts extra road users.
- Is it possible?
  Especially in urban areas, the limited amount of space reduces the possibilities to expand motorways with extra lanes.
- Are we allowed?
  Air and noise pollution legislative rules are strict. Inhabitants in the area or an almost extinct ant or vegetation can put plans on hold for years.

Use of existing infrastructure solves some of these problems. Since the nineties tests on the temporary use of hard shoulder have been carried out in several Member States leading to the deployment of over 1000 kilometres hard shoulder running measures on the TERN.

Service definition

Hard shoulder running enables dynamic use of hard shoulders with the aim to increase road capacity.

The use of existing infrastructure can be highly efficient and safe, but requires precautions to at least maintain the regular safety level. Examples of precautions are lower speed limits and visual control via cameras or other extra surveillance methods.

Hard shoulder running:
- is applied for bottlenecks/problem areas in the network with recurrent, but not constant, lack of capacity i.e. recurrent peak hour congestion;
- is usually triggered by traffic demand or at fixed times (peak hours);
- is similar to creating a dynamic extra lane and therefore requires dynamic traffic management control;
In specific cases hard shoulder running:
- can be referred to as peak hour lanes. It should be noted that these also can imply extra lanes, not necessarily hard shoulders;
- can be used for dedicated lanes, thus creating extra capacity for a dedicated set of road users like public transport;
- can be conceived as an interim solution to counter capacity problems; in that case it is applied in a relatively short time, until the regular expansion of a motorway is possible.

Service objectives
The aim of hard shoulder running is a capacity increase on a section of the road network to avoid (heavy) congestion and to reduce the probability of incidents. Hard shoulder running can only be implemented when the safety level remains the same or improves.

Disruption / problem to consider

Original function of hard shoulder
A hard shoulder has a specific set of users like emergency services, police and road users with car trouble. Opening the hard shoulder to all road users can cause problems for its original users. Their needs must always be kept in consideration.

Possible negative impact
Hard shoulder running can only be applied on route sections or network areas with strongly varying traffic volumes and very stringent capacity problems. The measures are used with strict safety precautions to maintain the existing level of safety and are only allowed if special criteria are met like ‘no expected increase of emission levels’.

Road user compliance/acceptance/understanding
Deployment of a hard shoulder running measure gives the hard shoulder an ambiguous character. This can cause confusing situations for the road users. I.e. a commuter who is accustomed to an open hard shoulder during peak hours, can expect it to be open off peak hours as well or road users that are unaware you are allowed to drive on the hard shoulder will not adapt to a new lane, which can cause dangerous situations. Good un-ambiguous instructions and education can counter these problems.
### Conditions for the deployment of this service

The deployment of hard shoulder running is recommended for parts of the TERN network with the characteristics as indicated in the table below.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Hard Shoulder Running</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physical</strong></td>
<td>Motorway</td>
</tr>
<tr>
<td></td>
<td>• Construction of hard shoulder suitable for a heavy traffic load.</td>
</tr>
<tr>
<td></td>
<td>• Possibility to deploy the measures at and between junctions</td>
</tr>
<tr>
<td><strong>Network</strong></td>
<td>Corridor</td>
</tr>
<tr>
<td></td>
<td>• Network must be able to cope with extra capacity upstream.</td>
</tr>
<tr>
<td><strong>Traffic flow</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Daily traffic related problems, frequent congestion problems</td>
</tr>
<tr>
<td></td>
<td>• Traffic volumes close to the road capacity</td>
</tr>
<tr>
<td><strong>Weather</strong></td>
<td>N.A.</td>
</tr>
<tr>
<td></td>
<td>It must be stressed that hard shoulder running can only be applied when it does not create unsafe situations. For instance in case of adverse weather conditions the hard shoulder will not be opened or closed immediately if open. And at locations with recurring or regular adverse weather conditions hard shoulder will probably not be feasible.</td>
</tr>
<tr>
<td><strong>Safety</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• No specific safety problems, so not possible at high risk bottlenecks</td>
</tr>
<tr>
<td><strong>Environment</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• No specific environmental problems. I.e. If capacity increase leads to unacceptable emission levels, this service is not advisable.</td>
</tr>
<tr>
<td><strong>Freight</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• No specific freight issues. I.e. If a route is used for Transport Exceptionelle, maybe the hard shoulder is not suitable for freight transport and the service is not feasible at such a section..</td>
</tr>
</tbody>
</table>
1.2. European dimension

Existing differing aspects:
- Differing scenarios for opening and closing lanes
  - I.e. a workshop on hard shoulder use in 2006 showed many differences in indicating if the hard shoulder is closed or not.
  - The normal situation shows the road, where hard shoulder running is possible, but where the hard shoulder is closed.

- Different legislation for speed indication/control
- Differing systems for incident detection and monitoring
- Differing safety protocols

Proposed harmonisation for future deployments:
- The main European aspect of Hard shoulder running is instructing the road user in a safe and unambiguous way. Harmonisation of future deployments should be performed in two main areas:
  - Similar unambiguous instructions for road users on how to behave when facing an open or closing hard shoulder on the basis of agreements on protocols. The work group of the European Study ES4 “Mare Nostrum”, for instance, is contributing to the creation of a common users’ interface all over Europe. This common interface, once developed, would be very useful for the purposes of the harmonization of instructions.
  - Safety protocols for deployment of hard shoulder running and for scenarios when to open or close the hard shoulder.
1.3. Contribution to EasyWay objective

Several studies in Europe show positive effects from hard shoulder running. The increase of capacity and thereby the reduction of congestion contributes to all EasyWay objectives:

**Safety**
Hard shoulder running enables the temporary, demand-responsive capacity increase of sections. This results in a better distribution of traffic, which allows road users to adjust easier to dangerous situations reducing accidents.
The impact analysis of comparable systems confirms the positive effect on the traffic safety.

**Network efficiency**
A demand-oriented increase of the capacity on route sections and at junctions results in an improvement of traffic flow in the whole network area concerned. From the point of view of users, this contributes as well to a more regular traffic flow (due to a better use of road capacities) and to a reduction of travel time losses.

**Environmental impact**
Systems for dynamic lane management have positive effects on the traffic flow and reduce traffic-related congestion and accidents (followed by further congestion). By means of traffic smoothing, noise and pollutant emissions are reduced.

1.4. State of the art

Hard shoulder running is a complex and delicate combination of traffic measures and ITS. Although many European countries have gained much experience with some form of hard shoulder running in the past years, very little are all-rounded or presume the service is fully developed.

Depending on organization and functional area a check of the carriageway is done by video cameras or patrol cars of traffic inspectors, which could be done in the future by automatic scan function before the release of a lane. Detected incidents, stranded cars or obstructions on the hard shoulder are transmitted to the operator. After determination of the required security level the operator starts and stops the release of the hard shoulder. For visualization, matrix signs are applied as well as variable routing signs (in LED or prism technology).
2. Technical issues

2.1. Functional and information architecture

Functions:
Hard shoulder running is carried out according to the conditions of the control algorithm – high traffic demand, day time-dependent or due to manual request.

Release of the hard shoulder is carried out via the functions:

- **Monitoring** – Collect real time information on the traffic situation of the network
- **Safeguarding** – Secure the hard shoulder is free of debris, obstructing the safe use of the hard shoulder and free of vehicles within a certain time frame.
- **Dynamic information** – Inform the road user if the hard shoulder is open or closed
  - Open: Signing above the hard shoulder indicates either the allowed speed limit or a symbol like a green arrow pointed downwards. In addition dynamic or static signing alongside to the road can provide the road user with re-assurance; the hard shoulder can be used.
  - Close/clearing: To start the clearing process, a yellow flashing arrow pointing diagonally downward should be used as transition signal. The clearing process can take place by means of lane change that can be done for the whole section simultaneously or forward by means of discharging.
- **Safety precautions** – Options for broken down cars to leave the road (extra safe havens), reduction of the speed limit, extra visual control.
- **Evaluation and legislation** – Time administration hard shoulder open and closed. Procedures to determine when a hard shoulder should be open or closed (time, traffic volume).

In case of failure of the hard shoulder running signalization the system must be transferred into a safe condition.
In some cases enforcement via cameras is used to avoid illegal use of the hard shoulder, when it is closed (only relevant when enforcement is in the scope of the road operator).

System architecture:

**External facilities:** video cameras, variable direction signs, information panels, permanent light signs, barriers, signal heads, traffic data and surrounding data detection facilities.

**Control:** Local control stations with data input/output devices, connection to energy and data supply

**Centre:** (sub)-centre with operation and visualization, control software, reporting and archiving system

Crucial elements of hard shoulder running are a clear and safe signalization, presentation and monitoring of the current traffic guidance. The application of LED road markers at cross-over sections or intersection approaches/exits is a proven means to support lane allocation like hard shoulder running.

Display components of hard shoulder running, apart from static information panels, are:
Variable message signs for closing or release of the hard shoulder are traffic information panels in LED or prism technology, which have to be mounted above the carriageway.

As with dynamic lane management, hard shoulder running on cross-over sections or intersections requires a temporarily “remarking” of the traffic area, realized by (LED) road markers in the carriageway.

Manual surveillance, video cameras and automatic scan function inform the operator in case of detected obstacles.

Remarking of the road on cross-over sections and intersections are different for every situation, but should maintain the same goal: create a clear and unambiguous traffic situation for the road user.

### 2.2. Required ICT Infrastructure

Possible useful ICT systems and infrastructure for hard shoulder running:

- Real time detection systems (loops, cameras, radar, laser)
- Dynamic information systems for the road user (i.e. VMS, text-cars)
- Communication between hard shoulder running location and the traffic control centre (glass fibre, GSM, DECT)
- Visual control along the entire section of hard shoulder running (i.e. cameras, extra lighting for dark periods)
- Decision support systems (automated incident detection, automatic indication if hard shoulder should be open/close)

The automatic incident system has to be well calibrated in order to minimize the number of false alarms. It is also important to detail what type of incident/accident has to be detected by the automatic incident system (pedestrian, breakdown vehicle, animal, vehicle running the wrong way down the lane, ...)

### 2.3. Standards and agreements (existing and required)

In general, law and legislation must allow use of hard shoulders – on a national and European level (AGR- European agreement on international main arteries).

Protocols to inform emergency services, break down services and police and road operators on the status of the hard shoulder are advisable to avoid conflict situations.

Per Member State different standards and guidelines are used for the hard shoulder measures. This does not necessarily affect the uniformity for the road user.

**Relevant existing guidelines**

**General:**

- RiLSA Richtlinien für Lichtsignalanlagen an Straßen (guidelines for light signal systems at roads),(FGSV 1992, 2003c)
• Hinweise zu variablen Fahrstreifenzuteilungen – Anwendungsbeispiele und Einsatzmöglichkeiten (Recommendations on dynamic lane management – application examples and deployment potential), FGSV, Cologne 2003d
• Instruction interministérielle sur la signalisation routière, 6ème partie, feux de circulation (this French document notably deals with red crosses and green arrows).
• Instruction interministérielle sur la signalisation routière, 6ème partie, signalisation d’exploitation (this french document, to be published soon, notably deals with all active traffic management applications).

For the installation of sub-centres and traffic control centres:
• Merkblatt Ausstattung von Verkehrsrechnerzentralen und Unterzentralen (MARZ 99) (technical bulletin for the equipment of traffic control centres and sub-centres), edited by the Federal Highway Research Institute (BASt)
• Technische Lieferbedingungen für Streckenstationen, TLS, (Technical specifications for local control stations 2002, edited by the Federal Highway Research Institute (BASt)

For the equipment with variable message signs:
• Guidelines for variable message signs (RWVZ)
• “Panneaux de signalisation à messages variables / Guide technique” (French VMS Guide, Sétra, 1994).
• Vienna Convention, ed.2009. This new edition comprises several pages dedicated to VMS
• Guidelines for the composition of messages, Italian Ministry of Transportation and Aiscat.

Recommended new European guidelines:
• Necessary safety precautions before opening and closing the hard shoulder
• Harmonised signing to indicate if the hard shoulder is open or not
• Harmonised approach for road markings at junctions and cross sections

2.4. Need for additional specifications

With regard to display variants, the safeguarding measures as well as the control procedure, there are only first approaches to standardize the systems and functionalities of systems for hard shoulder running. A medium-term objective should be to harmonize at least the basic principles of the technical components of control and European-wide application criteria. A standard or guideline should be developed to promote uniformity in the appearance of the road and road signing.
2.5. Criteria and methods for the technical evaluation of the measure

**Quantitative**
To evaluate the impact of hard shoulder running on safety, network efficiency and environment, it is necessary to collect data from cameras, loops and radar or other monitoring devices installed along the interested section. Nevertheless, the type of data collected and their interpretation need to be considered before collecting data, creating and possibly using a database. Also, data from all available monitoring devices needs to be comparable. When collecting data from cameras sufficient data storage can become a problem, efficient use of capacity is advisable.

**General data required for evaluation:**
- Monitoring data
  - Congestion
  - Traffic volumes
  - Incidents
  - Weather conditions
- Logging Hard shoulder running measure
  - Date
  - Start time/end time
  - Reason release hard shoulder
  - Congestion level
  - Average speed
  - Duration
- Logging failure notices
  - Failure of the systems,
  - Switching command which has not been carried out,
  - Improper command.

**Qualitative**
From a qualitative point of view questionnaires can be prepared and distributed in order to know users’ opinions about their feeling on safety and network efficiency. Road operators could also be addressed with such questionnaires, differently formulated, in order to share their experiences of the impact of the dynamic allocation of lanes on environment, safety and traffic flows.

As far as safety is concerned, the use of hard shoulder running implies a decrease of the accident rate above all if the infrastructure has been significantly adapted to its use. From the point of view of users, they surely feel safer when traffic flows are correctly managed, mainly because of the fact that speed is lower.

To determine the impact of hard shoulder running on safety the following aspects must be determined:
- Quantitative: Accident rate, road user acceptance
- Qualitative: road user experience

As far as network efficiency is concerned, the hard shoulder running enables an increase in infrastructure capacity to keep a constant traffic flow and lower, speed reducing congestion. Compliance of the road user is another relevant aspect of network efficiency. The percentage of vehicles driving on the hard shoulder determines the extra capacity.
To determine the impact of hard shoulder running on network efficiency the following aspects must be determined:

- Quantitative: traffic intensities, traffic flow, average speed, road user acceptance
- Qualitative: road user experience

As far as environment is concerned, due to the constant traffic flow, emissions may be reduced. Their levels can be monitored by special tools installed along the section interested by the dynamic management of the lane. However, using special algorithms, traffic intensities together with vehicle classification can also give a good indication of the emission levels. In addition to that, one could also monitor the noise.

To determine the impact of hard shoulder running on environment the levels of emission (noise and pollution), traffic intensities, average speed must be determined.
3. Service provision

3.1. Service implementation

Stakeholders involvement:

Road authorities
The road authorities are responsible for the planning, development and operation of the systems for hard shoulder running. The corresponding guidelines, regulations and references have to be taken into account. For the implementation and later operation, the optimization of traffic safety and traffic flow has to be the primary target. In this context all possibilities have to be exploited in view of an economic realization and later of the parameterization and regular test of the operation. The respective competences of the responsible authorities have to be considered here.

Forces of law and order:
The operator or, in case he/she has no unlimited access to the operational area per video system, the police or the staff of the responsible highway surveillance on site have to prove first, if switching is feasible. Only after their explicit release the measure can be activated. When the hard shoulder is open, constant surveillance is needed until the hard shoulder closes again.

Regular users of the hard shoulder
A hard shoulder has a specific set of users like emergency services, police and road users with car trouble. Opening the hard shoulder to all road users can cause problems for its original users. Their needs must always be kept in consideration.

Resources:
- **Material means:**
  - Real time detection systems (loops, cameras, radar, laser)
  - Dynamic information systems for the road user (i.e. VMS, text-cars)
  - Communication between hard shoulder running location and the traffic control centre (glass fibre, GSM, DECT)
  - Visual control (i.e. cameras, extra lighting for dark periods)
  - Decision support systems (automated incident detection, automatic indication if hard shoulder should be open/close)
- **Human resources:**
  - Traffic inspectors for surveillance (and control)
  - Traffic managers for control
  - Software developers for decision support systems, control systems and evaluation tools
  - Civil engineers for feasibility assessment before deployment

Since hard shoulder necessitates considerable safety requirements, only a semi-automated operation is possible. At least the personnel support by e.g. operators in a traffic control centre with unlimited video access is necessary.
3.2. Costs and benefits analysis

The benefit of hard shoulder running results in the reduction of traffic- and accident-related congestion. Particularly in case of highly varying traffic demand and in combination with other measures of traffic control, the cost-benefit analysis leads to a positive result. In a pre-assessment the following points should be considered particularly:

- Traffic volumes and load situation on different work days (daily graphs) at different day times.
- Traffic due to special events on the section to be signalized and also short-term varying load situations (e.g. varying peak traffic streams during phase of arrival and departure).

Further influencing variables on economic efficiency are:

- Length and frequency of measure.
- Number of influenced vehicles.
- Connection with other measures.
- Complexity of the system.

It is important to bear in mind that the evaluation area should be wide enough. Otherwise, one could miss the fact that some problems are simply solved themselves.

A study on the A4-A86 in France shows an increase of capacity of 900 veh / h by use of hard shoulder running, in comparison with reference situation.
3.3. End user orientation

Common end-user interface:
Hard shoulder running is displayed to users by means of Variable Message Signs. Variable Message Signs should be as much harmonised as possible, so as to be more comprehensible to users. See ES4 'Mare Nostrum'. VMS, matrix signs, static signing.

End-user acceptance:
Road user acceptance can be increased by education and unambiguous information on the road. The road user needs to understand the measure, be able to use it and want to use it. It is very important to not only inform the road user on the road, but also beforehand on the goal of the measure.

Some examples
Since 1st January 2002 the traffic signs 223.2 and 223.3 are available in Germany, regulating the use of hard shoulders.

![Sign 223.1](image)
![Sign 223.2](image)
![Sign 223.3](image)

In the French experience, only one VMS is used in order to inform the user that he is allowed to drive on the hard shoulder running.

![Dutch example of hard shoulder running - closed](image)
![Dutch example of hard shoulder running - open](image)
3.4. Service Level definition

<table>
<thead>
<tr>
<th>Element of Hard Shoulder Running</th>
<th>Level of Deployment</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Monitoring</td>
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<tr>
<td>Enforcement</td>
<td>Physical and periodical</td>
</tr>
</tbody>
</table>

Note: “Enforcement” has to be considered a complementary criterion in the identification of level of deployment, depending on national or regional policies and local characteristics of the service implementation. The “enforcement” criteria could not be considered as critical or mandatory while achieving a level of service. Therefore, binding obligations concerning the implementation of enforcement could not be imposed on EasyWay partners.

Hard shoulder running can be carried out in a first stage or in case of very rare application, by the police / traffic officers without technical installations.
3.5. **Regulatory Framework (existing / need for)**

The current legislation which might affect hard shoulder running is:
- Traffic related legislation
- Spatial planning
- Environmental legislation

It is necessary to study the need for European legislation with regards to hard shoulder running.

3.6. **Interaction with other services**

Hard shoulder running interacts with other services identified within EasyWay:
- TMS-DG02 Speed Control:
- TMS-DG01 Dynamic Lane Management:
- TMS-DG08 Incident Management:
- Variable Message Signs.

3.7. **Conditions for service provision – Business model**

Hard shoulder running is one of a number of strategies employed to increase the overall efficiency of the road network, reduce point-to-point travel times and increase road safety. It is an important tool in the reduction of congestion with impressive results.

3.8. **Adverse effects of the service**

Incident Management can become more complex; an extra step in the Incident Management process is needed: Check if the hard shoulder is clear or can be cleared.

3.9. **Overview of foreseen deployment within EasyWay**

An intensive collaboration between international stakeholders involved in the development of ITS systems connected to all typologies of dynamic management services is desirable in the near future at a European-wide level: this collaboration would inevitably lead to innovative, well-thought and harmonised systems having positive effects to road safety as well.
4. Bibliography and examples of deployment

4.1. Bibliography

- INRETS bibliography:

- Interim Advice Note (IAN) 111/09 – Hard Shoulder Running and IAN 112/08 Through Junction Hard Shoulder Running
- Leitfaden Verkehrstelematik, BMVBW
- Seitenstreifenfreigabe Autobahnen, ADAC
- "Spitstroken" – 15 July version – updated version in progress – end of 2009 (English)
4.2. Examples implementation EasyWay

<table>
<thead>
<tr>
<th>Country</th>
<th>Year – status quo</th>
<th>Deployment</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Netherlands</td>
<td>2008</td>
<td>148 km of HSR, an extension is envisaged to 235 km</td>
</tr>
<tr>
<td>Germany</td>
<td>2007</td>
<td>250 km of temporary operational HSR, a supplement of 150 km is programmed. 250 km of temporary operational HSR, a supplement of 100 km is programmed</td>
</tr>
<tr>
<td>France</td>
<td></td>
<td>A3-A86, A4-A86, A48, A1,... Many study projects particularly in “Île de France” region.</td>
</tr>
<tr>
<td>United Kingdom</td>
<td></td>
<td>40 km deployed, 400 km of HSR identified by Highways Agency</td>
</tr>
</tbody>
</table>
Example 1: Active Traffic Management – Highways Agency - England

- **Context:**
  On 12 September 2006, motorists on the M42 in the West Midlands were the first in the country to be able to drive on the hard shoulder during busy periods as part of a scheme aimed at cutting congestion.
  The scheme, called Active Traffic Management, is between junctions 3A and 7 and directs drivers to use the hard shoulder during times of peak congestion using electronic signs above each lane. Together with variable speed limits, which help smooth the flow of traffic, the scheme has had great success in reducing congestion on the M42.

- **System implemented:**
  Safety was of critical importance during the design of the scheme and emergency refuge areas are provided at regular intervals to provide motorists with a safe place to stop away from the traffic in the event of problems with their vehicle. These refuge areas are linked by telephone and CCTV cameras to the nearby regional control centre.
  The Highways Agency also worked closely with the emergency services to help them access the motorway in the event of an incident. Highways Agency control room staff have access to over 200 cameras on the 11 mile stretch, allowing them to easily spot any incident as it occurs. They can then close any individual lane or lanes by putting a red ‘X’ on the electronic signs above the lane(s) affected. This will then protect the vehicles involved in the incident as well as clearing the lane to allow emergency vehicle access.
  Compared with road widening, Active Traffic Management is significantly more cost effective but provides comparable benefits including increased capacity, reduced journey times, increased journey time reliability, lower emissions and lower fuel consumption.

- **Responsible of the implementation/contact:**
  For more information: [http://www.highways.gov.uk/knowledge/1361.aspx](http://www.highways.gov.uk/knowledge/1361.aspx)
Example 2: ZSM programme - Rijkswaterstaat – The Netherlands

- **Context: ZSM programme in The Netherlands**
  Due to European legislation with regards to emission levels, Rijkswaterstaat was unable to build additional lanes to the existing road network. A short term hard shoulder running programme was set up to increase road capacity at highly congested areas in The Netherlands. For every location Rijkswaterstaat had to prove in advance the hard shoulder running measure would not worsen the emission levels.

- **System implemented:**
  From 2005 to 2007, 150 km hard shoulder running was implemented at several highly congested areas on the Dutch main road network.
  Typical hard shoulder running for Rijkswaterstaat involves:
  - Video monitoring
  - Extra monitoring on the hard shoulder
  - Extra VMS above the hard shoulder
  - Static prism signs alongside the road
  - adaptation of the hard shoulder, with extra safe havens
  - Widening hard shoulder (sometimes)
  The positive results have lead to a second deployment programme in 2008-2010.

- **Responsible of the implementation/contact:**
  Edwin Verhagen: Edwin.verhagen@rws.nl
Example 3: Hard Shoulder Release and Line control - Frankfurt

- **Context:**
  - A3 south of Frankfurt interchange (Hesse)
  - A5 between Friedberg and Northwest interchange Frankfurt (Hesse)

- **System implemented:**
  In Hesse the temporary hard shoulder release is usually connected with a line control system. The control is carried out via corresponding sub- and video centres, which are connected to the traffic control centre Hesse. Video cameras, installed along the whole section, check whether the hard shoulder is free of breakdown vans, objects or other obstacles. The check by the staff in the TCC is repeated both directly before and after the release in regular intervals. This enables the immediate annulation of the release in case of, e.g. a breakdown. Outside the peak hours the hard shoulder remains blocked for flowing traffic.

- **Responsible of the implementation/contact:**
  Hessisches Landesamt für Straßen- und Verkehrswesen, Verkehrszentrale Hessen
  Westerbachstraße 73-79
  D-60489 Frankfurt am Main
  Phone: +49 69/743057-0
Example 4: Ring Munich, Autobahndirektion Südbayern

- **Context:**
  Motorway ring Munich (A99)

- **System implemented:**
  On the motorway ring road Munich a traffic control system was installed to improve traffic safety and reduce the frequent congestion. In case of increased traffic volume and speed breakdowns the hard shoulder release is automatically suggested. An operator checks then by means of the additionally installed video surveillance system whether the hard shoulder is free of obstacles and its usability. Only then the hard shoulder is released connected with a situation-dependent speed limit. The installed variable message signs above the hard shoulder allow a quick closure if necessary.

- **Responsible of the implementation/contact:**
  Autobahndirektion Südbayern, Verkehrsrechnerzentrale
  Heidemannstr. 219, D- 80939 Munich
Example 5: Motorway A73 - Autobahndirektion Nordbayern

- **Context:**
  Motorway A73, section access point Möhrendorf - access point Erlangen-Bruck
  Due to its position in the network it is mainly regional commuter and economic traffic on the A73 with destination Nuremberg-centre, -port, stadium and Nuremberg Fair; moreover supra-regional traffic particularly in times of high traffic volume on the parallel A9 in the East.
  The A73 avails of a 2x2 cross-section that is extended to 3 lanes into a continuous merging lane in the direction of Nuremberg between access point Möhrendorf and access point Erlangen-Bruck by means of reallocation of the hard shoulder. A 2x3 full extension is not possible due to the restricted conditions in the urban area.
  In the planning area there are altogether four access points, which lead here – in the urban area of Erlangen – to an urban motorway character by the dense consecution of access and exit points. The temporary hard shoulder release is carried out by lane signalization and variable guidance panels (WVLT), their functionality can be monitored by video camera, that also take over event detection (e.g. the detection of drivers in the wrong direction, breakdowns and pedestrians).

- **System implemented:**
  Temporary hard shoulder release with line control system on the federal motorway A73, section access point Möhrendorf – access point Erlangen-Bruck incl. video detection, section length about 6.4 km.
  Especially on the incident-prone section all possible technical measures have to be planned to avoid accidents and to reduce the effect of incidents on the motorway. For this reason the hard shoulder release is complemented by the installation of a line control system.

**Responsible of the implementation/contact:**
Autobahndirektion Nordbayern
Flaschenhofstraße 55
90402 Nürnberg
Example 6: Study on the A4-A86’s operation - INRETS - France

- **Context:**
  Socio-economic evaluation is based on dispense-advantage method. Impacts taken into account include time effect, environment effect (without noise nuisance) and road safety. Every variant of road operating is then qualified according to the sum of its "monetary effects".

- **System implemented:**
  On the network’s motorway about common section influence, the decrease of the total time passed in traffic is about a winning of, 4 549 vehicles hour (veh*h) during working days, 3 094 veh*h on Saturday and 3 958 veh*h on Sunday. On the public economical counting convention base, the annual time winning in 2006 is about 1 226 906 veh*h (16 388 224 €) in comparison with 2003's data.
  On the same influence network, the decrease of principal emission of pollutants, of gas with greenhouse effect, and consumption is about an annual economy of 3 144 823 € in comparison of the reference situation of 2003.
  In comparison with 2002-2003's period, the promotion of the impact on road security in 2006 is about a winning of 5 235 000 €.
  The total investment of 19 M€ must be in relation with the total and annual effective winning (without noise nuisance) estimated to 24,8 M€. The common section A4-A86’s operation is secured a return in less than one year.

**Responsible of the implementation/contact:**
CERTU/SETRA's group
Example 7: section A4-A86 – INRETS-DIRIF - France

- **Context:**
  Hard shoulder running on the section A4-A86 in France.

- **System implemented:**
  Results evaluation Hard shoulder running:
  - Increase of capacity of 900 veh / h by use of the dynamic auxiliary way, in comparison with reference situation.
  - The principal emission of pollutants and gas with greenhouse effect decrease like the energy consumption. The reduction attains 20 % for oxides of nitrogen, 39 % for the monoxide of carbon and more than 85 % for the dioxide of sulphur. It is about 4,25 % for greenhouse effect gases, 15 % for the consumption of essence.
  - During the traffic saturation and with the auxiliary way open, sound level increase about 2,2 dB (A), while the ear receives a variation of noise only from a difference of 3 dB (A). Moreover, the new set up surfacing decreases this sound savings from 4 to 7 dB (A). For the rest of the day and the night, there is not increase of the traffic flow and the sound balance sheet remains always favourable with the use of this new tarmacadam.
  - There's a decrease of accident about 8%. This tendency is not significant because of the weak size of samples and it deserves to be deepened and confirmed.

**Responsible of the implementation/contact:**
INRETS