CEDR

Conférence Européenne des Directeurs des Routes

Conference of European Directors of Roads

# Best practice in European traffic incident management


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*This document expresses solely the current view of CEDR. Readers should not regard these views as a statement of the official position of CEDR's Member States.*

This report is: **FOR DECISION**

## Executive summary

E.1 Traffic incidents not only cause danger to and loss of life[1], they also cause congestion and generate economic costs. Across Europe, road incidents account for 10–25% of congestion. One objective of the EC's ITS Action Plan and Directive is to reduce congestion and increase safety and efficiency. CEDR's specific remit is to optimise the use of the capacity of the road system. Incident management is one way of both doing this and contributing to the EC's objectives. Non-injury accidents are also estimated to cause considerable congestion: 30% in the Netherlands and up to 60% in the USA, where average traffic density is lower. CEDR's SP2 task group 13 (Incident and Emergency Management) aims to define and promote best practice in European incident management and to provide tools for the practice and development of incident management across the countries of Europe, taking account of their various conditions and resources.

E.2 The focus of the task is on the strategic road networks within the remit of NRAs, ranging from critical points such as tunnels to the entire Trans-European Road Network (TERN). Its approach is to set out a framework within which NRAs can set and develop their capability. Much of this is derived from NRAs' experience with established TIM practices and national guidelines. However, a guiding principle is to allow for differences between NRAs' overall remits and national needs and resources, while pointing out where harmonisation would be beneficial.

E.3 A protocol for cooperation between CEDR and EasyWay has been agreed. One consideration is to coordinate with EasyWay while avoiding unnecessary duplication. However, since NRAs will be the ones implementing any recommendations or directives concerned with incident management, part of the coordination work is to ensure that NRAs are happy with the results.

E.4 This document is the final report deliverable from CEDR SP2 task group 13 (Incident and Emergency Management) in Thematic Domain Operation. It is supported by an earlier interim report analysing a web-based survey on traffic incident management in CEDR member states. The strategy for task 13 was developed by the preceding SP1 task group O5 (Traffic Incident Management).

E.5 The first part of the report is as a conventional task report. It outlines the motivation, composition, strategy, methodology, and results of the task, as well as issues 'for decision'. This is followed by appendices devoted to best practice at operational, tactical, and strategic levels. Appendix A is a framework guide that summarises the essential components and factors in TIM including the cycle of phases which make up the critical timeline. Appendix B addresses wider concepts for effective TIM including international best practice. Appendix C highlights both the role of TIM in relation to the EC's ITS Action Plan and the EasyWay project and paths for development of TIM capability. Appendix D contains definitions and references.

[1] Around 40,000 people are killed on the EU's roads every year.

E.6 In addition, a portable A5-sized aide-mémoire for NRAs and responders has been produced. This aide-mémoire lists appropriate actions in the different phases of incident management and contains useful mnemonics and definitions, while allowing for different levels of TIM implementation.

E.7 Apart from safety issues, congestion is a major consequence of incidents. In the survey, six countries reported that they see TIM as a way of reducing congestion, while only two reported that they did not see TIM as a way of reducing congestion following non-injury incidents.

E.8 Effective TIM can reduce both safety and non-safety related costs by:

- reducing response and clearance times as well as total management time by making improvements that focus on the most critical or longest components of the response timeline;
- reducing the risk of secondary incidents;
- ensuring the safety of incident responders;
- maximising the use of available responses.

E.9 Incident prevention is a natural companion of incident management. Just as incidents arise from combinations of factors, so successful incident prevention may depend on a combination of measures: analysis and intelligence, driver information and education, and physical measures.

E.10 In many countries, incident management is not only led by but also mainly implemented by the police. The police's primary responsibility tends to be public safety and criminal investigation; rapid clearance and the minimisation of congestion tend to be reduced priorities. Because of their legal status, any modification of the role of the police may involve delicate negotiations with them and other responders who are affected.

E.11 The NRAs of seven countries surveyed have either already taken over roles from the police or would like to. Taking over roles from the police—e.g. by setting up a dedicated traffic officer service with limited legal powers—involves a substantial investment in staff, equipment, and training, and consequently involves significant risk. It is most appropriate in those cases where the target network is well defined and carries high traffic volumes, and where monitoring and control are already well developed. However, it could also be a way forward in those cases where the development of traffic and incident management would mean undesirable extra responsibilities for the police. An intermediate approach might be to set up civilian patrols to monitor road and traffic conditions and report anomalies. This is an area where much may be gained from the exchange of experience between countries. It is hoped that TISPOL could become involved in mapping out development paths.

E.12 Recognising the benefits and potential of incident management identified by this task group and described in the results of its work, it is recommended that national road administrations:

1) collect appropriate data from their own business and key stakeholders and work with national policymakers to identify the operational and economic opportunities of incident management;

2) utilise and adapt the outputs of this task and work with operational partners to:
   a) maximise the value of existing national incident management capability and
   b) develop national incident management capability;

3) establish methods of monitoring their incident management performance and benefits realisation;

4) set up through CEDR an annual European forum on incident management at which members could share and review incident management best practice across Europe (it is proposed that the first forum should coincide with TRA 2012).

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# 1 Introduction to incident management

## What is traffic incident management?

1.1 Traffic incident management (TIM) is a structured response to road traffic incidents. The remit of TIM is to develop joint working practices between national road administrations, the police, and other incident responders to ensure the mutual achievement of objectives including the safety of both road users and responders, reduced congestion and economic costs, and improved travel reliability and efficiency. As will be described in detail in this document, it can in practice be defined by a sequence of phases from the discovery of the incident to its clearance and the restoration of normality. Incident prevention is a natural companion of incident management. Just as incidents arise from combinations of factors, so successful incident prevention may depend on a combination of measures: analysis and intelligence, driver information and education, and physical measures.

## Goals of TIM in relation to traffic management and network efficiency

1.2 Across Europe, incidents account for 10–25% of congestion. Non-injury accidents are also estimated to cause considerable congestion, 30% in the Netherlands (CEDR 2009) and up to 60% in the USA, where average traffic density is lower (Chou et al 2010). CEDR's specific remit is to optimise the use of the capacity of the road system. Traffic incident management (TIM) can be viewed as one part of an integrated service to road users, whose parts are related to each other (see Fig. 1) and contribute in different ways to the efficiency of the road system.

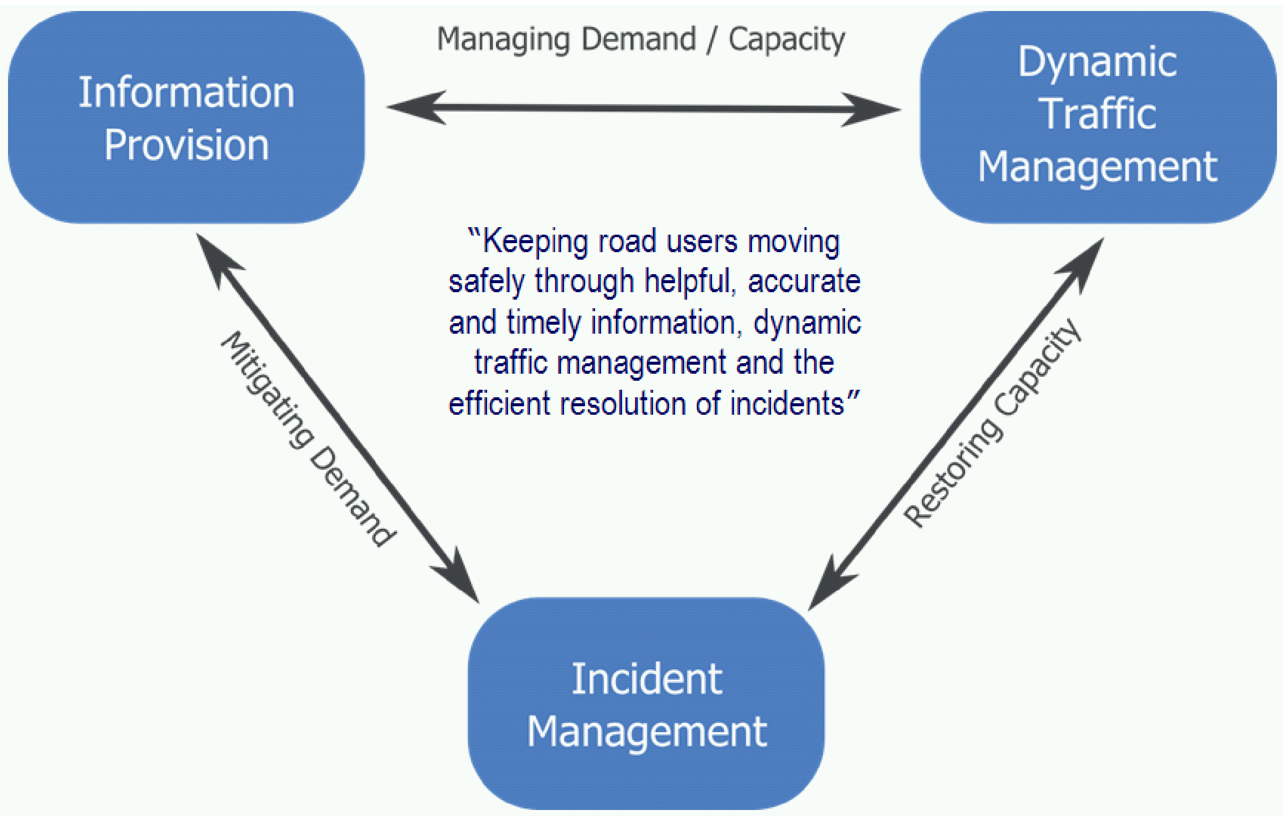


Fig. 1: The relationship between incident management and other traffic management services

1.3 By achieving a balance between these elements, more efficient use of network capacity can be achieved. Effective TIM can reduce both safety-related and non-safety-related costs by:

- reducing response and clearance times and total management time by making improvements that focus on the most critical or longest components of the response timeline;
- reducing the risk of secondary incidents;
- ensuring the safety of incident responders;
- maximising the use of available resources.

## Role of national road administrations

1.4 The Conference of European Directors of Roads (CEDR) represents the national road authorities or their equivalent bodies. The focus of this document is naturally on strategic road networks within the remit of NRAs, from critical points such as tunnels to the entire TERN. Having said that, TIM is a team effort between emergency responders with specialist skills and specific remits, and in many cases it is not the NRAs that lead incident response but another responder, in particular the police.

1.5 The approach of this document is to set out a best practice framework within which NRAs can set and develop their capability in coordination with other responders. Much of this is derived from the experience gained by NRAs with established TIM practices and national guidelines, primarily but not exclusively within Europe (see for example Highways Agency (2007, 2009), Verkeerscentrum Nederland (2010), FHWA (2009a, b, 2010b)). However, its primary objective is to engage more CEDR members, taking account of differences between NRAs' remits and national conditions and resources across Europe, while indicating where harmonisation would be beneficial.

1.6 In the **CEDR survey** on NRAs' incident management and prevention policies, methods, and plans, a web-based questionnaire was used to obtain data from 18 of CEDR's 21 member states and the State of Victoria in Australia, which kindly agreed to contribute (CEDR 2010b). How NRAs view TIM as a way of reducing congestion depends on their responsibilities. Six countries reported that they see TIM as a way of reducing congestion, while only two reported that they did not see TIM as a way of reducing congestion following non-injury incidents. Several countries pointed out that congestion is either not their primary focus or is managed mainly by diversions. Some countries did not answer this question.

1.7 A key indicator of the scope of an NRA's responsibility is the size of the road network for which it is responsible. In countries with heavily used road networks, NRAs are typically responsible for between 10% and 25% of all roads, but in less densely populated countries, the percentage can be much lower. An NRA's responsibility usually extends only to the busiest and most strategic roads such as motorways and primary trunk roads, these also being the most likely to be in the Trans-European Road Network (TERN) and to be used by international traffic. However, its responsibility may be restricted to critical points such as tunnels and bridges. One issue for TIM is how best it can be developed as an NRA's responsibilities evolve or its coverage is extended.

## Coordination with other projects in Europe

1.8 The EasyWay project has delivered 19 guidelines on aspects of transport, one of which is traffic incident management (EasyWay 2009b). A protocol for cooperation between CEDR and EasyWay has been agreed, and coordination mechanisms are in place with EasyWay both at governance level (through TD OPERATION) and at technical level (through task group 14), with the aim of achieving consistency without duplication. However, it is NRAs that will be the ones implementing findings and any directives, and this document has been prepared by and on behalf of NRAs with that in mind.

## Responders and stakeholders who may be involved in incident management

1.9 In addition to NRAs, the following responders/stakeholders may be involved in various stages of incident management and may have defined roles, including that of leading the response:

- traffic management centres and network operators (where distinct from the NRA)
- the police (and police associations)
- the fire and rescue service
- ambulances and paramedics
- traffic officer services (where established, usually by the NRA)
- specialist support services such as incident support units
- vehicle recovery contractors
- road maintenance contractors, for infrastructure repair
- specialist services for dealing with hazardous materials (HAZMAT)
- traffic information services
- driver associations (AA, AAA, ADAC, RAC etc)
- insurers

## Ten points that form the backbone of incident management

1.10 While this report expresses clear views on best practice, it does recognise the diversity of NRA remits and capabilities within the countries that have been consulted and does not, therefore, seek to prescribe in detail how incident management should be delivered. However, certain procedures have been found to be successful, and the following ten points are considered the backbone of TIM practice:

1. Speedy detection and response
2. Good information about location, severity, and any attendant hazards
3. Protection of the scene and ensuring the safety of responders, victims, and the public
4. Coordinated response with a clear structure of authority, roles, and responsibility
5. Reliable communications between responders and with the public
6. Provision of appropriate equipment, facilities, access paths, and management
7. Sufficient backup services to ensure speedy clearance to minimise congestion
8. Information exchange through training and debriefing systems
9. Written guidelines and formal agreements, where necessary
10. Monitoring, performance assessment, and feedback into practice.

Fig. 2: The ten points that make up the backbone of incident management

## 2 Content of task group 13's report and deliverables

2.1 This part of the CEDR task 13 final report is a conventional task report that describes the motivation, composition, strategy, methodology, and results of the task. It also contains issues, recommendations, and several appendices. Sections are numbered consecutively.

2.2 The appendices deal with best practice at operational, tactical ,and strategic levels

Appendix A is a manual for responders and managers. It outlines essential actions and the types of equipment and supporting systems that have been found to be successful.

Appendix B goes deeper into underlying issues such as safety, congestion, and the relationship between different responders.

Appendix C is devoted to higher-level issues of policy, planning, and the development of capability, which are also addressed in the main report.

Appendix D lists common definitions and references that are relevant to all sections.

2.3 In addition to this report, a pocket-sized aide-mémoire for the guidance of responders on-scene has been produced. The cover and first pages of the aide-mémoire are illustrated in Fig. 3. This short, 20-page A5-sized ring-bound manual lists appropriate actions in the different phases of incident management (represented by the 'wheel') together with useful mnemonics and definitions.


Fig. 3: Cover and first page of the aide-mémoire (the actual document is A5 in size and ring bound)

# 3 Task 13: group and project

3.1 This whole document is the final deliverable from CEDR Strategic Plan 2 task group 13 (Incident and Emergency Management). Task 13 is one of four related PG ITS tasks in Thematic Domain Operation (TDO). These tasks include:

Task 11 Comparison of Congestion Policies of NRAs (completed in early 2010)
Task 12 Traffic Management to Reduce Congestion
Task 13 Incident and Emergency Management
Task 14 NRA roles in ITS, EasyWay, eSafety (including technical coordination)

3.2 Task 13 follows the strategy defined by task group O5 (Traffic Incident Management) during CEDR's Strategic Plan 1 (CEDR 2009)[2]. Task group 13, which worked from April 2009 until March 2011, drew information on incident management policy, practice, and planning from a web-based survey of all CEDR members that was conducted in August 2009. A full report on this survey was provided in the task group's interim report (CEDR 2010b). Information was also drawn from the experience of its own members and other sources. The task group held five workshops, counts among its members the CEDR representative on eCall implementation, and adheres to a protocol on coordination with the other ITS-related tasks and the EasyWay project.

## Task 13 group members

3.3 Task group 13 consists of NRA representatives from eleven countries. It was led by the Highways Agency.

| Country | NRA or representative organisation |
|---|---|
| Austria | ASFiNAG |
| Belgium-Flanders[3] | Agentschap Wegen en Verkeer |
| Denmark | Vejdirektoratet |
| England | English Highways Agency (task leader) |
| Finland | FINNRA |
| Iceland[3] | Vegagerdin |
| Italy | StradeANAS |
| The Netherlands | Rijkswaterstaat |
| Norway | Statens vegvesen |
| Slovenia | Slovenian Roads Agency (also in eCall) |
| Sweden | Trafikverket[4] |

[2] A French-language version of the task 5 final report is available from the CEDR Secretariat; a Flemish-language summary of the results of task 5 case studies can be found in Heikoop (2009).
[3] Belgium and Iceland did not participate in the workshops but had the opportunity to contribute.
[4] Formerly Vägverket (prior to the incorporation of rail transport)

## Workshops and other venues

3.4 Apart from the final meeting at Schiphol, workshops were held at Brussels Airport for ease of accessibility and economy. Papers and presentations were given at the TRA 2010 Conference of 7–10 June 2010 (Taylor 2010) and at the EasyWay Annual Forum in Lisbon, 16–18 November 2010 in a special technical session on incident management originally proposed by task group 13.

# 4 Strategy and methodology

4.1 The strategy originally developed by SP1 task group 05 consists of six points:

- **Reviewing the different approaches taken by NRAs** and focusing on how the necessary skills, processes, and capabilities have been developed, by taking forward previous findings and engaging more CEDR members to get a wider picture through a web-based survey of all CEDR members' TIM policies and practices, leading to a manual of best practice in European incident management, as reported in the interim report (CEDR 2010b).
- **Coordinating incident management initiatives** with those of other CEDR ITS tasks, EasyWay, eCall, and the ITS Action Plan. To help achieve this, CEDR and EasyWay have established a protocol for cooperation at governance level through Thematic Domain Operations and at technical level through task group 14. Moreover, task group 13 is represented in the eCall Implementation Task Force. In addition, the task group has participated in the 2010 EasyWay Forum and TRA 2010. Since NRAs will be the ones implementing any recommendations or directives concerned with incident management, part of the coordination work is to ensure that NRAs are happy with the results.
- **Defining the stages of incident/emergency timelines and investigating information sharing** by identifying and acknowledging each incident phase separately. This approach provides a structure within which roles and responsibilities of responders can be agreed and assigned. In turn this supports the effective management of incidents and the undertaking of post-incident reviews, where best practice can be identified and shared. This objective has already been addressed by NRAs and has resulted in a six-phase model of incident management (see Fig. 4). The phases and the actions in them follow a logical sequence and are not particularly dependent on the capabilities of NRAs, though they may not all be the responsibilities of NRAs.


Fig. 4

- **Gathering comparable data** on incident and emergency management performance to be used to drive improvements across Europe by defining and agreeing stages through workshops, the provision of data by members, and a comparison of performance. This more general objective is partly satisfied by the review and survey. However, for various reasons, it has proven difficult to measure performance and compare the associated cost-benefits of implementing TIM interventions. This topic is addressed in sections 18 and 22.

- **Promoting incident/emergency prevention** as a tool not only for safety but also for reducing congestion, by gathering information from NRAs on their present and planned incident prevention measures. This aspect is covered by the survey analysis.

- **Pursuing a European acceptable and standard format** to inform road users about the incident/emergency by contributing relevant incident-related information to work taken forward by the 'eSafety Roadmap'. This objective is considered to be achieved by monitoring developments in TPEG and DATEX II.

# 5 Results and issues

### Survey response

5.1 In addition to the countries represented in task group 13 (see Section 3.3), we are grateful to persons and organisations in the following countries inside and outside Europe who responded to the survey or contributed information:

| Country | NRA or Representative Organisation |
|---|---|
| Australia (State of Victoria) | VicRoads |
| Czech Republic | Road and Motorway Directorate |
| Estonia | Estonian Roads Administration |
| France | Ministère du Développement durable ... |
| Germany | BMVBS (Bundesministerium für Verkehr ...) |
| Latvia | Latvian Road Administration |
| Republic of Ireland | Road Safety Authority |
| Scotland | Transport Scotland |
| Switzerland | FEDRO |

5.2 Fig. 5 gives an indication of the contribution each country made to the survey. The blue bars represent direct responses to the survey; the orange bars indicate that the data was collected by other means. Not all questions carried the same weight; not all answers contained the same amount of detail.

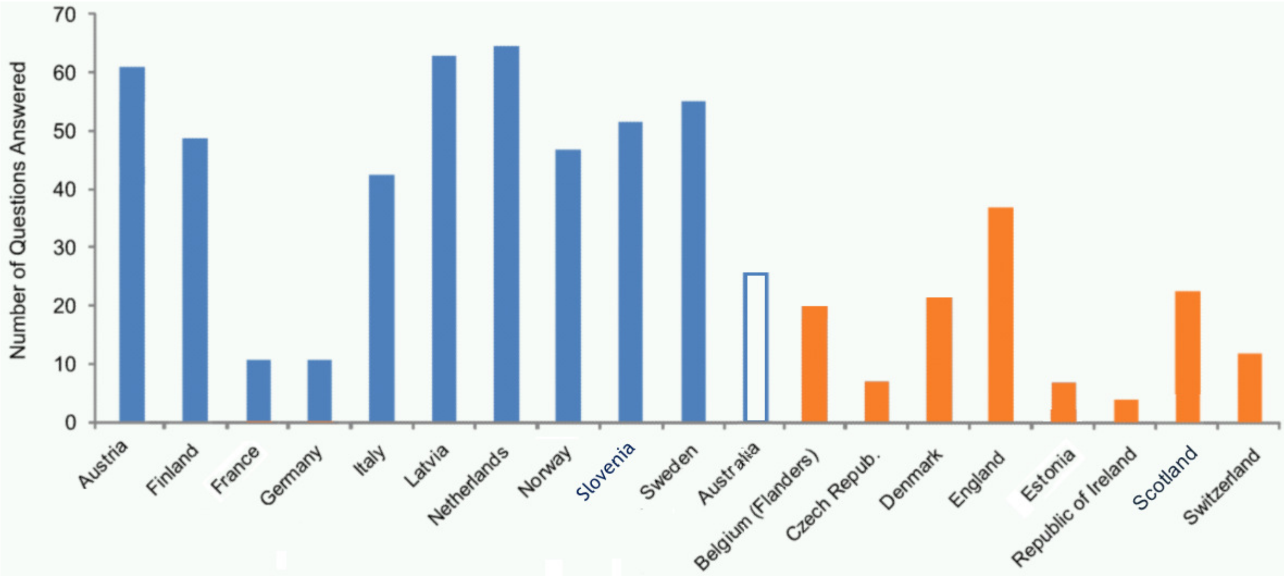


Fig. 5: Countries that contributed to the CEDR TIM survey, including the number of questions answered. The number of questions answered does not necessarily indicate the quality of information provided.

## NRAs' roles and responsibilities

5.3 Responsibilities for traffic incident management vary considerably from country to country, and practices vary accordingly. The main determinants of variation are:

- remits and priorities (e.g. concentration on protecting tunnels or major arteries);
- the nature and density of the road network and traffic;
- the role of the police versus that of the road authority;
- the existence of service level agreements with TIM partners and contractors.

5.4 Moreover, it can be said that countries are 'at different stages of development'. However this presumes both a progression of stages and a need to progress through them. The 'TIM Space' diagram (see Fig. 6) may appear to convey this message. However, closer inspection reveals that the differences are essentially ones of coverage, along the three dimensions shown, and that development, as suggested by the trajectory arrow, arises from extending coverage along one or more dimensions. While there is no prescription that NRAs with lower levels of coverage necessarily ought to extend it, the report aims to facilitate this process.

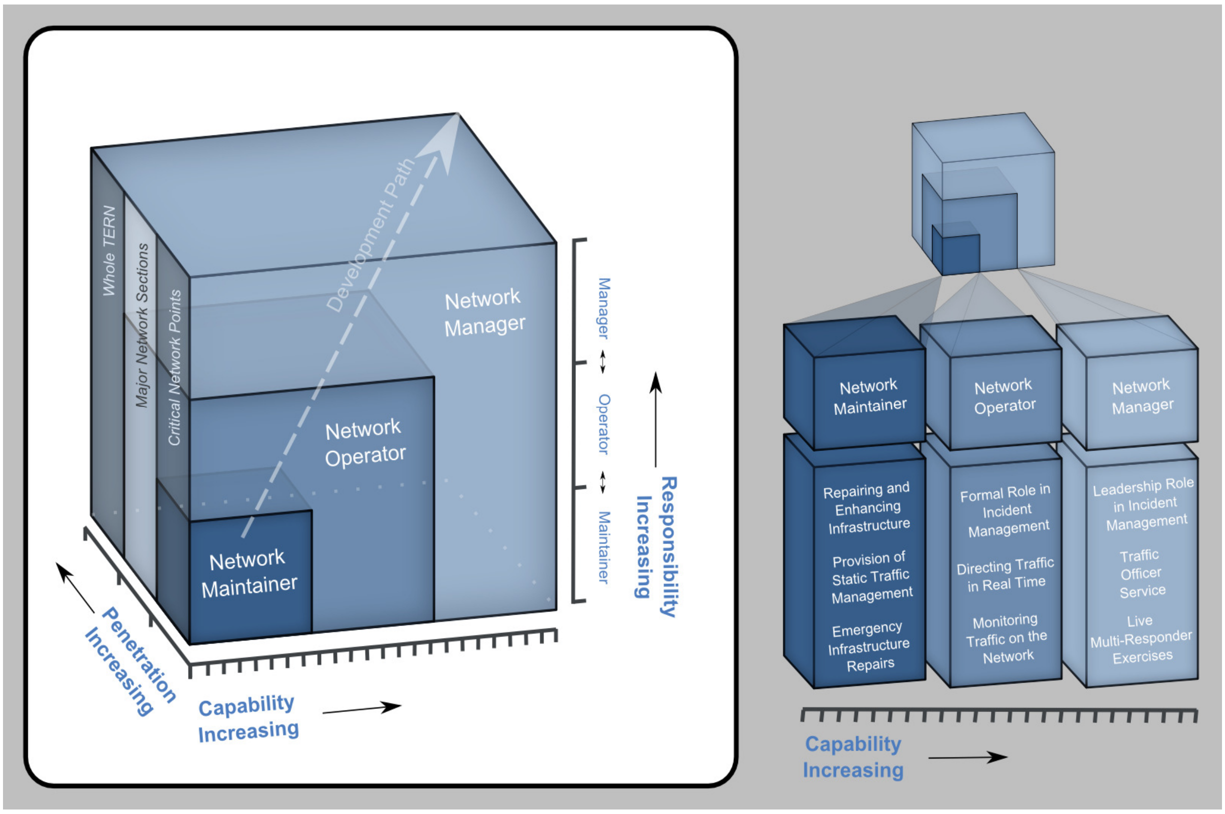


Fig. 6: The 'TIM space'

5.5 Coverage has been characterised by three types of role:

- network maintainers, who maintain a safe and usable infrastructure
- network operators, who detect, coordinate, and provide information
- network managers, who actively manage incident response and congestion

5.6 There are also three levels of service (identical except in name to those defined by EasyWay):

- Basic: covering critical points such as bridges or tunnels
- Enhanced: also covering major roads with daily traffic or critical weather problems
- Intensive: covering 100% of the TERN network

5.7 Within this operating framework, incident management is achieved by deploying various elements or resources, and by moving through the sequence of phases illustrated in Fig. 6.

5.8 In practice, these determinants overlap. What can be done on the ground depends on what is already in place or available in terms of staff, vehicles, fixed hardware, communication systems, and coordination procedures. Conversely, what is put in place will depend on what is considered necessary or practical. There can be no definitive, prescriptive order in which these elements should be deployed. For example, the Netherlands' gantry system, with its national deployment and high-bandwidth data communications, could be considered a system that was put in place before the need was universal, while the UK's 'managed motorway' systems could be seen as a targeted response to critical conditions on certain road sections. The former system, once in place, leads to actions that make use of it, while the latter system is seen to produce benefits, which subsequently lead to its further roll-out.

5.9 Consistent provision between countries and across borders may be impaired if neighbouring countries use radically different methods, so harmonisation is essential wherever close cross-border or supra-national relationships exist. This can be the case:

- where borders are crossed by critical infrastructure like bridges or tunnels;
- where road users from many countries need to understand signs and procedures.

### Institutional roles of NRAs

5.10 The scope of an NRA's activity is defined by its institutional roles in government. Where different government agencies are responsible for incident management, clear boundaries of authority and lines of coordination need to be defined. In contrast, technology (including ITS) tends to leap over boundaries and create new opportunities for better working. Therefore, the rethinking of constitutional roles is significantly driven by technology. Within NRAs too, roles may be split across internal structures, for example between a policy division and traffic management centres, and between national and regional levels. Ideas that work well in one country, within one institutional structure, may not work elsewhere. This can be a barrier to the transfer of specific elements of best practice between countries, hence the focus of this document on frameworks.

### Traffic officer services and the role of the police

5.11 One question that is a matter of concern for several NRAs is whether and to what extent they should assume roles currently played by the police, including the setting up of a dedicated traffic officer service (TOS). The police's primary responsibility tends to be for public safety and criminal investigation; rapid clearance and the minimisation of congestion tend to be reduced priorities. Because of their legal status, any modification of the role of the police may involve delicate negotiations with them and other responders who are affected. Based on the web survey, NRAs from seven countries (**Austria, Australia (Victoria State), Denmark, England, Netherlands, Norway,** and **Switzerland)** either already have taken over roles from the police, or indicated that they would like to.

5.12 Taking over roles from the police—typically by setting up a traffic officer service with limited legal powers—requires a potentially lengthy and difficult process of cost-benefit evaluation, and also involves a substantial investment in staff, equipment, and training, and consequently involves significant risk. It is most appropriate in those cases where the target network is well defined and carries high traffic volumes, and where monitoring and control are already well developed. However, it could also be a way forward in those cases where developing traffic and incident management would mean undesirable extra responsibilities for the police. An intermediate approach might be to set up civilian patrols to monitor road and traffic conditions and report anomalies. This is an area where much may be gained from the exchange experience between countries.

## Common themes from the survey

5.13 Several common themes emerged from the analysis of the survey:

- Low-technology solutions have still not been fully exploited. Benefits can be derived from using simple procedures or technologies that do not rely on a fixed infrastructure, such as buffer vehicles to protect incident scenes, portable screens, and specialist teams.
- The early stages of the incident management cycle, while critical when trying to reduce the total time for managing an incident, are also technically complex, depending on specialist equipment and skills, and involve major investment in the form of detection and surveillance equipment, eCall, line control systems, traffic officer patrols etc.
- In later stages of the incident management cycle, in particular 'recovery' and 'restoration to normality', efficiency can provide major benefits by reducing the overall timeline. Many NRAs use sub contractors in these phases; targets, incentives, and penalties are often written into contracts.
- As the primary mode of communication, GSM telephones are simple, cheap, and available to all incident responders. Dedicated communications systems such as TETRA provide a higher level of reliability and more effective information dissemination, but are more expensive, and may therefore need to be justified explicitly by the benefits they provide.
- Multi-responder policy reviews and exercises (both 'table-top' and live) are a direct and practical way of developing and testing coordination between responders and TIM procedures.

## Intelligent transportation systems/services including eCall

5.14 ITS and other technologies are increasingly being used for incident management. All NRAs now use the Internet to inform road users about road conditions in varying detail, and many use web-based logging systems. On the carriageway, automated signals (both advisory and mandatory) and variable message signs are becoming more common and are used to ensure queue protection and provide traveller information. In incident management, the ability to speed up response times is the main driver of ITS, eCall being an example applied to individual road users (eCall 2009). Automatic incident detection (AID) systems have existed for many years. Traditional AID relies on inference from limited data from one or two detectors, which unless limited to a relative tightly-defined condition, such as the detection of dense slow-moving queues, can be prone to generating false alarms. As more holistic or 'intelligent' methods come on stream, such as image analysis, the role of automated incident detection and protection systems may increase.

## Incident prevention in the survey

5.15 Primary incident prevention measures identified in the survey are shown in Fig. 4: current measures on the left, planned measures on the right. The ranking of planned measures may depend not only on their merits but also on the extent to which other measures have already been deployed. However, it seems that there is a movement towards 'intelligence' either in the sense of intelligence-gathering through the systematic accumulation of data or through information technologies. Some measures for preventing secondary incidents have also been identified (see CEDR 2010b). These are largely concerned with protecting the scene of the primary incident (see section 23).

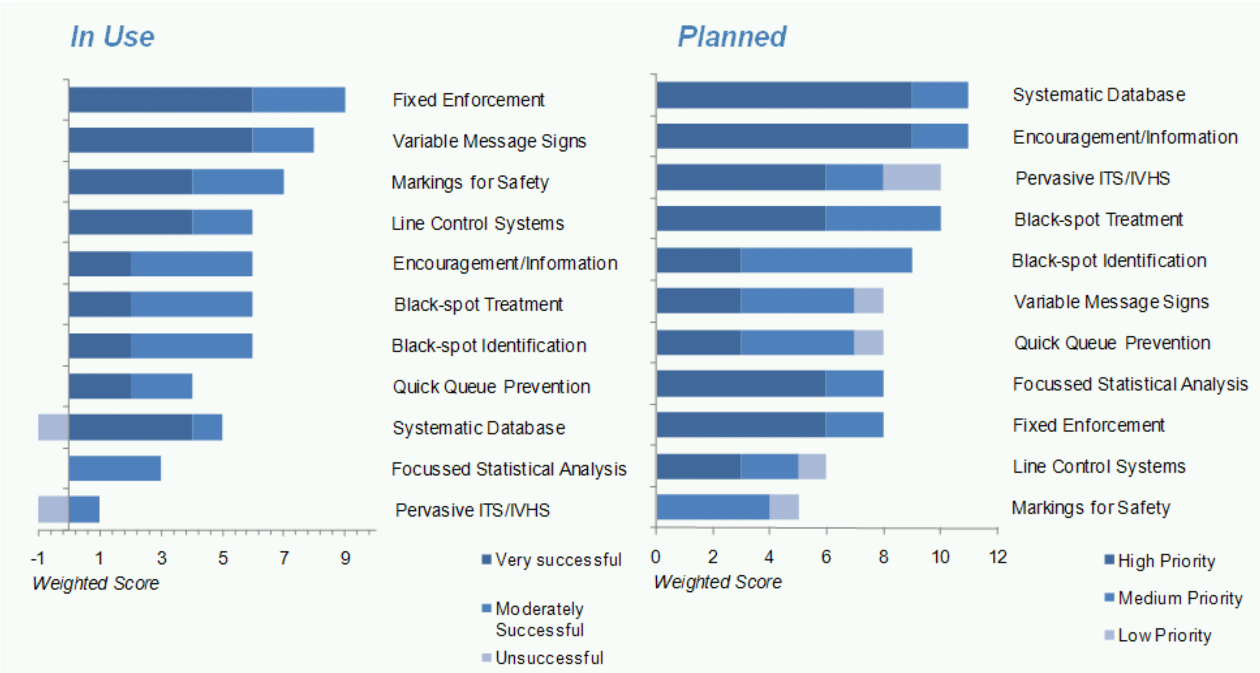


Fig. 7: Current and planned primary incident prevention measures (source: TIM survey)

## Severe weather conditions

5.16 Recent periods of heavy snow in many parts of Europe and the USA have shown that the challenges associated with deploying TIM in such circumstances can be different to issues associated with deploying TIM in 'normal' conditions. Apart from the inevitable widespread nature of disruption, inadequacy of equipment, and difficulty of access, very specific factors played a role:

- jack-knifed trucks blocking carriageways after drivers lose control of their vehicles in the snow;
- cars blocking the hard shoulder after drivers attempt (probably illegally) to by-pass queues.

5.17 Severe weather conditions raise technical, legal, and even social issues which, while urgent, are too dependent on local conditions to be dealt with here.

## Emergency management

5.18 The title of the task 13 project is 'Incident and Emergency Management'. Although the web-based survey included a section on emergency management, it became clear that national priorities vary hugely from country to county, emergency management issues are different from incident management issues, and emergencies tend to have highly specific management procedures. Nevertheless, priorities for emergency management may reflect NRAs' prioritisation for incident management deployment. Survey recipients were asked to rank types of major emergencies as 'Considered', 'Important', or 'Priority' using the respective rank values 1, 2, and 3. The results are shown in Fig. 8, where the bars represent the number of responses weighted by ranking.

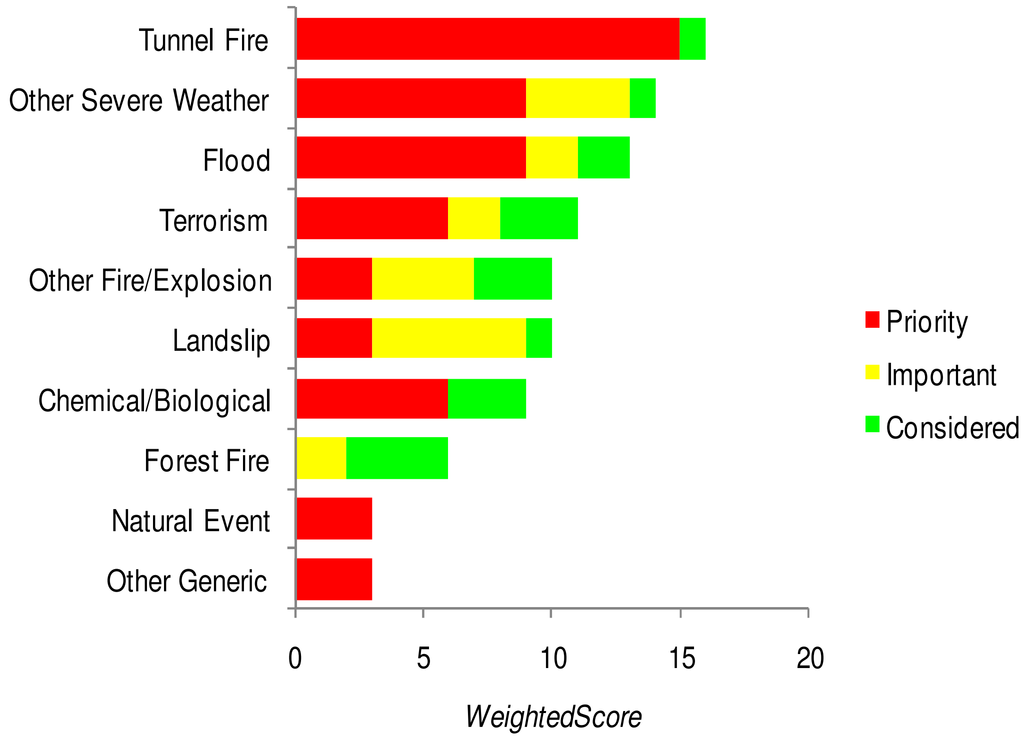


Fig. 8: Overall priority given to different types of emergency by European NRAs

5.19 Tunnel fires are seen as being the highest priority. This may reflect the prevalence of more mountainous or remote countries in that part of the survey. Most of the other higher-ranked major emergency types are environmentally linked. This suggests a growing concern among NRAs and incident responders about the possible impact of climate change on road network operations. Severe weather, flooding, fires, and landslip (i.e. landslides) are all particularly dangerous in more remote and inaccessible areas where the initial response time is likely to be long. The next priority is terrorism, for which no substantial information was provided other than that it is commonly recognised as a significant issue for the resilience of road networks.

5.20 The survey asked respondents to provide information about organisational structures for dealing with major emergencies. Some countries have special organisational and procedural structures for such events, for example:

- In **Austria,** emergencies are dealt with at provincial level. However, major emergencies may be declared a national disaster by the district governor. During an emergency, a change in command structure is often made. However there are no effects on the roles of ASFiNAG or its partners. As with 'normal' incidents, during an emergency, close cooperation and two-way communication are maintained with the response forces (police, fire brigade, rescue services).
- In **Denmark,** the police are responsible for setting up an emergency organisation involving the relevant players.
- **Finland** has special procedures and management procedures. Moreover, follow-up workshops are held after major emergencies to assess performance and identify any lessons learned.
- In **Italy,** emergency management is undertaken by the COEM group, which is based in the National Coordination Centre.
- In **Norway**, when a major emergency occurs, the manager of the regional NRA office makes the decision to set up an emergency organisation with other responder organisations to manage the event. Major emergency teams exist at all levels of NRA organisation.
- The **UK** government's Cabinet Office publishes general guidelines on risks and preparedness, including ones for transport (UK Resilience 2010).

5.21 Of the other countries that responded to the survey, the **Netherlands** has both special procedures and management structures, **Sweden** has special procedures but no special command structure, and **Latvia** reports that it has neither special procedures nor special command structures.

# 6 Ways forward

## Dissemination of best practice

6.1 The appendices to this report are intended to stand alone as a framework guide for best practice in incident management backed up by advice on concepts for effective incident management and development paths, which can be used as a reference manual. It is anticipated that the report will be published and made available to CEDR members and others. However, as with any large complex document, there is the risk that it may seem daunting to potential readers.

6.2 Publication will therefore need to be backed up by promotion. One way of achieving this is the distribution of a portable aide-mémoire entitled 'Best Practice in Incident Management', which contains concise summaries aimed at both NRAs and responders, similar in concept to those already produced by some NRAs but designed to be useful at all levels of service development.

## Future development of TIM practice

6.3 Unless travel behaviour changes substantially in the future, it is improbable that TIM coverage will deliberately be reduced. However, the way in which the outcomes of TIM are achieved could evolve as new technology becomes available in such a way that reduces the need for the commitment of traditional, physical incident management resources largely through the automation of TIM processes. For those countries starting from a relatively low level of traffic management and incident management, new technology may make it possible to achieve goals using distributed systems and wireless and gantry-less technology such as eCall, Cooperative Systems (e.g. CVIS, IVHS), and ad hoc networks (see sections 6.8 and 25). In short, it is necessary to consider best practice not only under current conditions, but also as something that will evolve as technology evolves. However, it is likely that there will always be a need to coordinate the diverse services involved in incident response.

## Learning loops and institutional barriers

6.4 Best practice can also evolve through experience and learning. CEDR's task group 11 was set up to compare NRAs' high-level congestion policies. Its final report (CEDR 2010a) states that while NRAs may have similar strategic goals and interventions, there is little or almost no direct relationship between goals and interventions and that there is a risk that the goals of society or organisations are not realistic, or that NRAs cannot influence or cannot adapt to changed goals. To alleviate this, task group 11 proposes the idea of the 'learning loop'.

6.5 One way of mitigating institutional cross-purposes is a tight cycle of monitoring and adjustment of implemented interventions, also taking advantage of modelling to enable potential interventions to be tested and evaluated before implementation (see Fig. 9). At a technical level, specific examples of 'learning loops' include the tuning of the variable speed limit setting algorithms for the first 'managed motorway' system on the M25 London Orbital in England and the optimisation of ramp metering systems, e.g. on the Amsterdam Ring in the Netherlands.

6.6 The principle can be extended to influencing high-level policy through intelligence, in the sense of systematic appraisal though broad-based data gathering. The reason that information needs to be broad based is that it is in practice very difficult to appraise interventions independently, since they are seldom applied in isolation and their effects cannot easily be separated from those of other interventions, which may not even be co-located.

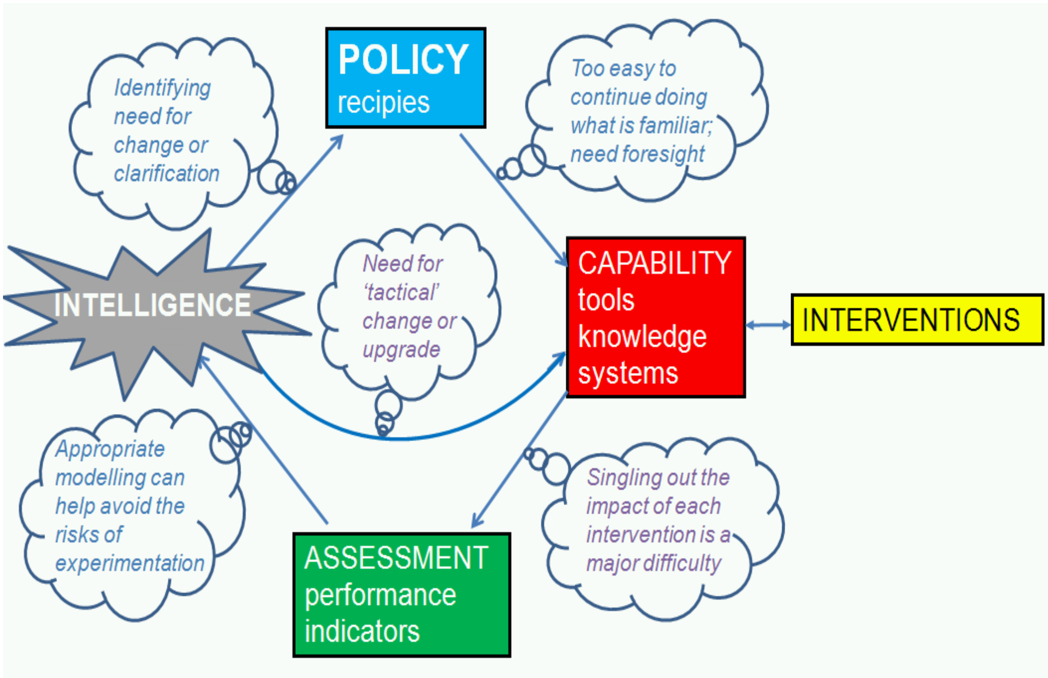

Fig. 9: The role of intelligence in TIM policy: an enhanced 'learning loop'

## Monitoring and feedback from best practice advice

6.7 Incident management policy and best practice typically evolve organically over many years. To continuously develop incident management capability, it is essential that the way in which incident management is delivered is actively monitored and reviewed on an ongoing basis.

In particular, the impact of the best practice manual itself should be monitored and its contents updated if necessary to reflect experience over a sufficient period. This is a process that has occurred, consciously or unconsciously, in those NRAs that have developed comprehensive guidelines. However, as this report is at pains to emphasise, defining a single framework of best practice for a region as diverse as Europe must be a more delicate and interactive process.

## The potential of cooperative vehicle–infrastructure systems

6.8 Current priorities for cooperative systems as identified by Pre-DRIVE C2X (2010) and others are fixed roadside hazard warnings and traffic information, underlining the importance of infrastructure in the cooperative system. In future, distributed intelligence may be based on ad hoc networks formed from transceivers carried in individual vehicles and backed up by a base network of fixed stations. Recent research has increased understanding of how these networks might work, in particular how mobile and fixed units need to be distributed to create a 'scale-free' network where reliable communication over both longer and shorter distances can be almost guaranteed.

However, there can be institutional barriers to deploying cooperative systems, barriers that may need to be overcome in non-technical ways, see for example Konstatinopoulou (2010).

6.9 It goes without saying that if incidents can be prevented in the first place, then incident management becomes less of an issue, but this begs the question as to whether incidents can be prevented cost-effectively. In any field where events have multiple random or practically unforeseeable causes, there will come a point where interventions deliver diminishing returns or where the cost of guaranteeing prevention becomes prohibitive. In road traffic, there is also the driver behaviour factor, which is largely absent in highly regulated and professional fields such as air transport.

6.10 Vehicle automation and cooperative systems may reduce or even eliminate the behaviour factor, particularly by preventing speeding and loss of control and by detecting hazardous situations (see for example FHWA 2010a, HAVEit 2010, Flemisch 2010). Automated road vehicles were proposed as early as 1939 and are becoming reality in the limited form of small 'people movers' such as EN-V (Brubaker 2010) and the PRT at Heathrow Airport. With current technology and a little imagination, one can foresee a time when not having such systems will seem as incredible as driving without a seat belt is today. Cooperative traffic management is foreseen as emerging from around 2018 onwards, and some cooperative services from 2015 (source: EasyWay Forum 2010).

6.11 As with all emerging technologies, there will be a period of experimentation and learning during which it would be wise to expect the unexpected. Implementing crude systems now could even be counterproductive if failures lead to a loss of confidence. The simplest cooperative systems device proposed is a forward-looking sensor which applies brakes or at least warns the driver when a hazard is detected in front of the vehicle. The question then arises as to how a mixture of vehicles (with and without these automated collision preventers) would behave?

6.12 For road traffic, the factors that may need to be taken into account are not yet known. Another significant issue is high sensitivity to equipment cost. Therefore systems will need to be able to accommodate gradual upgrading, e.g. the move from forward hazard sensing to all-round sensing, which may in turn bring unforeseen problems such as how to avoid false alarms and driver distraction.

### Developments in communications and traffic information

6.13 Two currently outstanding projects are DATEX II and TPEG, which have a momentum of their own. DATEX II is becoming a recognised standard for digital communications aimed at service providers. TPEG is an expert group developing protocols and formats for digital traffic information messages for road users. TPEG-based applications use a defined hierarchy of standard elements from which language-independent traffic messages may be constructed. When received by a suitable in-vehicle receiver or via other media, these messages are translated into voice or visual messages in the road user's own language. These complementary standards are currently a concern of EasyWay ESG5 and TISA (Traveller Information Services Association), which are seeking in particular to establish a technical standard that will allow DATEX II content to be translated into TPEG messages for end user services. It is anticipated that TPEG will be fully developed by 2015 (source: EasyWay Forum 2010).

### Engagement of the police (TISPOL)

6.14 Across Europe, about half of incident management situations are led by the police. For the reasons given above, a TOS is unlikely to be universally deployed. The strong cross-border element of road traffic is recognised by TISPOL, the European Traffic Police Network, which was established by the traffic police forces of Europe in order to improve road safety and law enforcement on the roads of Europe (see TISPOL 2010). TISPOL's main priority is to reduce the number of people being killed and seriously injured on Europe's roads and it believes that a significant contribution can be made by appropriate traffic law enforcement and education as well as incident management. It is hoped that TISPOL will become involved in mapping out development paths.

## 7 Conclusions and recommendations

7.1 This whole document is intended as a manual of best practice on incident management in Europe, representing the varied experience and contributions of national road administrations in a wide range of European countries. Information has been gathered from a survey on TIM practice, policies, and plans. Ten European countries and task group members responded; some data was collected from a further nine countries. Information was also taken from manuals and guidelines produced by NRAs that are highly active in TIM. The EasyWay Guideline on deployment of TIM and the objectives of the ITS Action Plan were also taken into account.

7.2 The appendices are intended as a reference resource for NRAs wishing to develop their capability; the companion aide-mémoire is intended as a portable and handy resource for both NRAs, responders, and other stakeholders.

7.3 Recognising the benefits and potential of incident management identified by this task and described in its results, it is recommended that national road administrations:

1) collect appropriate data from their own business and key stakeholders and work with national policy makers to identify the operational and economic opportunities of incident management;

2) utilise and adapt the outputs of this task and work with operational partners to:

    a) maximise the value of existing national incident management capability and

    b) develop national incident management capability;

3) establish methods of monitoring their incident management performance and benefits realisation;

4) set up through CEDR an annual European forum on incident management at which members could share and review incident management best practice across Europe (it is proposed that the first forum should coincide with TRA 2012).

## 8 Acknowledgments

8.1 This work forms part of CEDR's 2nd Strategic Plan, within Thematic Domain Operation's Project Group ITS. The task group is grateful to Mr Graham Dalton (chief executive of the English Highways Agency and member of the CEDR Governing Board), Andrew Jones (divisional director at the Highways Agency and member of the CEDR Executive Board), Mr Michel Egger (secretary-general of CEDR) and his staff, Mr Hans Jeekel, (Head of TD Operation), Mr Paul van der Kroon (Rijkswaterstaat, Head of PG ITS), the organisers of the TRA and the EasyWay Forum, and other NRA representatives who cooperated in the survey, including the following:

| Contributor | NRA/Country |
|---|---|
| Keith Weegburg | State of Victoria, Australia |
| Jacques Boussuge | ASFA, France |
| - | BMVBS federal ministry, Germany |
| Sandro la Monica | StradeANAS, Italy |
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| Steven Little | Transport Scotland |

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**For definitions and references see Appendix D**

# APPENDIX A

## Framework guide for traffic incident management

For definitions and references see Appendix D

# 9 NRAs' responsibilities, coverage, and levels of service

NRAs' incident management responsibilities vary from country to country, falling broadly into one of the three hierarchical service levels defined below. However, it does not follow that NRAs' entire traffic responsibilities must follow the same pattern. For example, an NRA with limited interest in TIM could still have a high level of responsibility for the safety and efficiency of the entire transport system. The way responsibilities are organised may also depend on political structure, e.g. the degree of regional autonomy within a country. For this reason, service levels should be understood in the specific context of incident management only.

## Network maintainers

1 ensure roads are cleared after incidents;
2 return the infrastructure to operating standard;
3 review the safe use of the network;
4 make corrective infrastructure changes to reduce incidents.

## Network operators (*as maintainers and also*)

1 coordinate incident response;
2 detect incidents using various technologies;
3 direct responders to the scene;
4 inform road users though signage or other media.


## Network managers (*as operators and also*)

1 play a direct role in incident management;
2 lead scene management (similar to or shared with the police and/or emergency services);
3 minimise network disruption from incidents.

## Coverage

9.1 Each country will deploy incident management according to its resources and priorities, which will depend on statutory, institutional, and geographical factors. Coverage or penetration of the road network can be broadly divided into three levels:

- critical points such as tunnels and bridges
- major strategic network sections and intersections
- the whole Trans-European Road Network (TERN)

9.2 Level of service is another category, which is somewhat less precise and can be broadly divided into:

- Basic: availability of police, fire, and ambulance services and some means of alerting
- Enhanced: coordinated services and traffic management centres
- Intensive: dedicated or integrated incident management, e.g. with traffic officer service.

## Development paths

9.3 Figures 6 and 41, which show the above categorisations and suggest the possibility of development paths leading to an extension of any or all of the following: responsibility, coverage or level of service, can be found in the main report and in Appendix C respectively, where developing capability as an incident manager is discussed in some detail. The essential elements of incident management are summarised below.

**These ten points make up the backbone of incident management:**

1. Speedy detection and response
2. Good information about location, severity, and any attendant hazards
3. Protection of the scene and ensuring the safety of responders, victims, and the public
4. Coordinated response with a clear structure of authority, roles, and responsibility
5. Reliable communications between responders and with the public
6. Provision of appropriate equipment, facilities, access paths, and control centres
7. Sufficient backup services to ensure speedy clearance to minimise congestion
8. Training and debriefing systems
9. Written guidelines and formal agreements, where necessary
10. Monitoring, performance assessment, and feedback into practice.

## 10 TIM phases and their objectives

The management of an incident can be broken down into a cyclic sequence of **phases**, progression through which constitutes the timeline of an individual incident. There is general agreement on the **objectives** during the TIM phases. The diagram shows the phases as a cycle that starts and finishes with a state of normality. The objectives are listed for each phase.

10.1 Actions in the phases of the TIM cycle illustrated are defined below.

### Discovery

- Implement immediate safety measures.
- Initiate early actions to protect the lives of road users.
- Initiate early actions to prevent an escalation of the incident.
- Obtain sufficient detail to enable an informed decision on the responder organisations to be involved and the type and level of response required.
- Establish initial command, control, and coordination of the incident.


### Verification

- Verify the nature and location of the incident.
- Identify the resources and organisations required for an initial response to the incident.
- Implement immediate safety measures.
- Identify and tackle the aspects that require immediate attention.
- Supply responders and their organisations with essential information.
- Establish initial command, control, and coordination of the incident scene.
- Plan the 'initial response' phase.

### Initial response

- Protect the scene.
- Save lives.
- Protect and preserve the lives of others.
- Preserve the scene for investigation.
- Safeguard property and infrastructure.
- Protect the environment.
- Commence initial investigation.
- Mitigate congestion.
- Plan the 'scene management' phase.

## Scene management

- Ensure that the activities at the scene are controlled and managed effectively by and through a clearly identifiable authority.
- Ensure the continued safety of the incident location.
- Preserve and protect life, property, and the environment.
- Prevent escalation of the incident and secondary incidents.
- Minimise disruption and congestion.
- Record details of the incident that are required for investigation.
- Secure and preserve evidence.
- Identify witnesses.
- Plan, prepare, and organise the 'recovery' phase.
- Ensure that there is a managed handover of the scene control when appropriate and ensure that all relevant parties are aware of it.

## Recovery

- Using safe work methods, quickly, effectively, and efficiently remove obstructions and return the road and other assets to a state allowing traffic flow to return to normality.
- Update traffic information to road users.
- Plan for the 'restoration to normality' phase.

## Restoration to normality

- Restore the traffic conditions to the level expected for that location at that time of day.
- To minimise congestion, this should be done in stages as lanes become serviceable, provided it is safe to do so.
- Ensure the final update of information when normality is achieved.
- After clearing an incident, while traffic may be flowing freely past the scene, there could still be delays on the approaches in both directions. Normality is not restored until these also return to the conditions expected for that location at that time.

## Normality

10.2 What constitutes normality is likely to depend on local and temporary variables such as time of the day, day of the week, month of the year ('seasonality'), weather conditions, physical road conditions, and volume, tidality, and quality of flow of traffic.

## Cycle model versus timeline model

10.3 The phases of the TIM process can also be visualised as extending along a linear timeline (see, for example, EasyWay 2009b). This allows for some overlap between phases, for example between 'initial response' and 'scene management'. However, except in detailed planning, it is felt that the nature of these overlaps is not well defined, and therefore the cycle model offers the most clarity. Examples of typical timelines and their critical paths are given in Appendix B.

## 11 Check-lists for essential first actions

Mnemonics and memorable lists can be helpful to people working under pressure, to ensure that essential actions are carried out and critical factors are taken into consideration. These cover the first three of the ten essential points.

11.1 Essential actions, information, and provision are summed up in the mnemonic **SAD CHALETS** developed by the English Highways Agency:

**S**urvey
**A**ssess
**D**isseminate

**C**asualties
**H**azards
**A**ccess routes for responders
**L**ocation
**E**mergency services required
**T**ype of incident
**S**afety of all at scene

11.2 The **IIMARCH** acronym may help to structure the command organisation and the information gathering process; the incoming information about the incident can be used to assist with decisions and briefings and to inform both tactical control and higher-level support (e.g. provision of resources), should it be required:

**I**nformation
**I**ntention
**M**ethod
**A**dministration
**R**esources
**C**ommunications
**H**ealth and safety

Location & assessment


Securing hazards


Saving casualties

Traffic management


Protection and screening


Preserving evidence

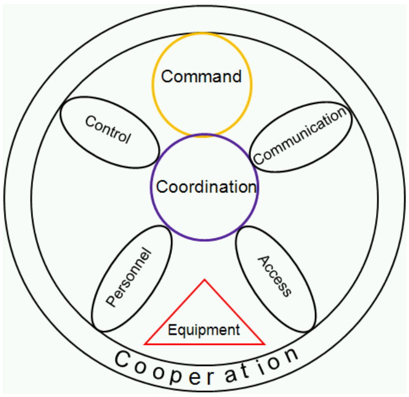
# 12 On-line and off-line components

The **components** of TIM are the identifiable aspects of TIM practice and TIM preparedness. The following mnemonics are intended to help characterise the different components required at the different levels of TIM practice and planning.

12.1 'On-line' components are those needed immediately in response to an incident, while 'off-line' components are those that improve overall TIM effectiveness either before or after an incident. A third category of 'Up/down-line' components captures longer-term issues that affect the overall way that TIM operates. Heading the on-line list are the 'Five Cs', which are identified as being essential to successful incident management at the scene.

**On-line**

Coordination
Cooperation
Communication
Control
Command
Access
Personnel
Equipment



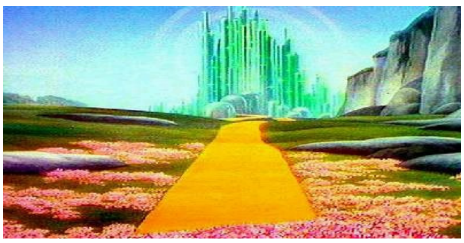

**Off-line**

Coverage
Analysis and evaluation
Debriefing of responders
Exercises
Training of responders

Planning of responses
Performance indicators
Information services
Education of road users


**Up/down-line**

Policy
Learning from experience
Aspirations
New technology and intelligence
Strategies for improvement



## The TIM 'grid'

12.2 One way of visualising the 'on-line' incident management process in general terms is shown schematically in Fig. 10. Incident management consists of deploying certain types of resources or actions, styled as components, in each of the TIM phases.

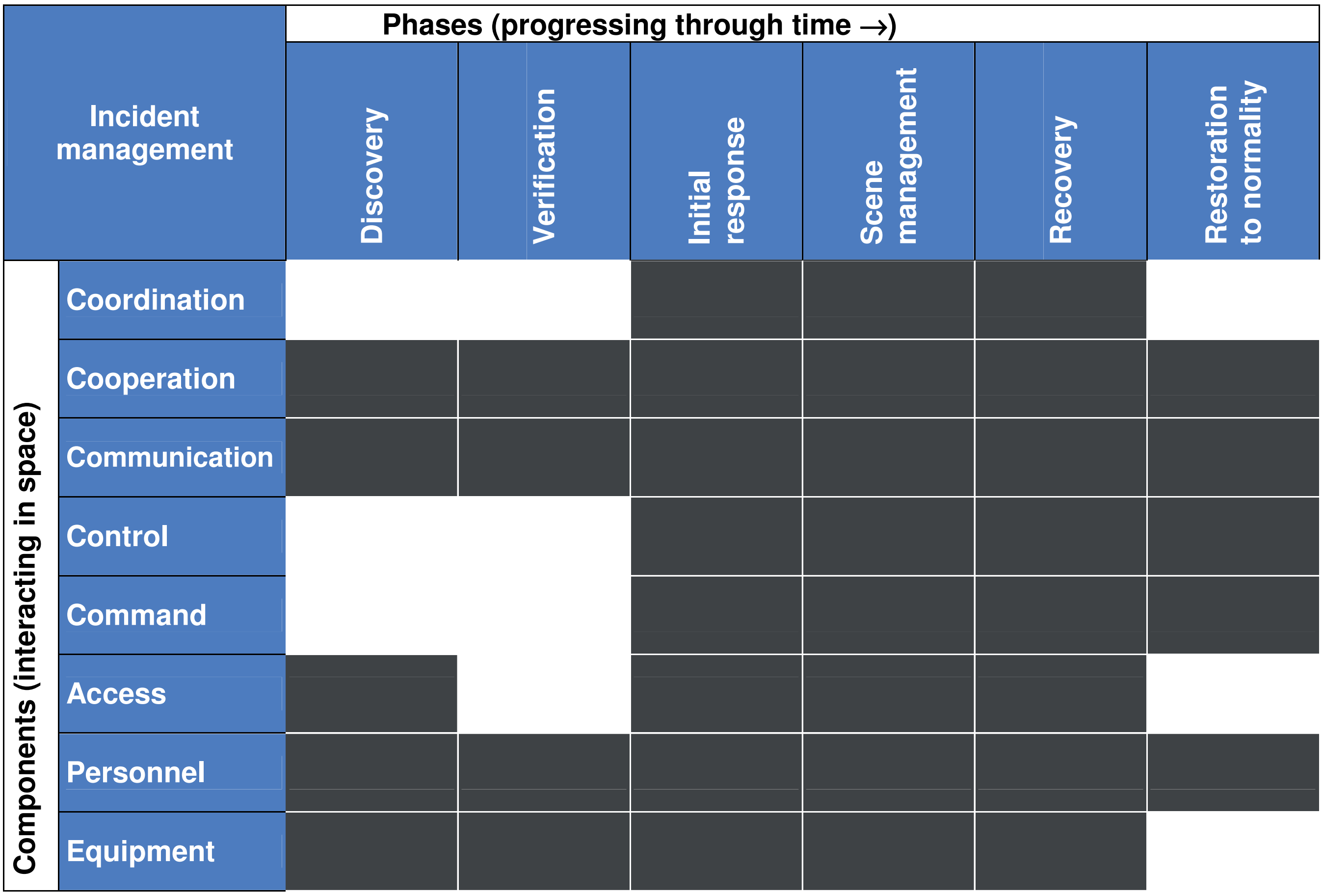



Fig. 10: The TIM grid

12.3 The purpose of visualising the TIM process in this way is to suggest that TIM is multi-dimensional. The various components and phases represent cross-sections in the process. The dark grey cells in Fig. 10 reflect the underlying approach to traffic incident management used by a network manager. This approach provides a diagnostic tool by which the other approaches can be compared.

12.4 Although in practice there may be some overlap between the phases, the order will remain unchanged. Likewise, although there may be some commonalities between the components, the need for all to be represented will remain. The components to be deployed or considered will depend on the level of service provided at the locations concerned. Specific detail is provided in section 14.

12.5 By examining how and why different NRAs would fill in this grid differently, areas for attention or development can be identified and remedied.

# 13 Supporting organisations and systems

Incident management can be viewed as a single type of intervention. However, unlike other traffic management measures (CEDR 2013), it embraces many interlinked elements, as indicated above. However, certain measures and facilities can be treated in isolation, and the following have been found beneficial.

## Organisational

13.1 **Traffic officer service (TOS) (England) / Weginspecteur/Officier van dienst (Netherlands)**: specially trained staff with defined legal powers to direct traffic and with a close relationship with traffic management centres (TMC)[5] in terms of monitoring and patrolling a strategic network (more details below).

Fig. 11: Traffic officers stopping and managing traffic

13.2 **Formal inter-responder agreements:** while these are always likely to be beneficial, they require each responder to have a clear understanding of its roles, responsibilities, and powers, and those of other responders, as well as formal performance targets and ways of ensuring they are achieved.

13.3 **Traffic information and the media:** it may be helpful to make formal arrangements with the media regarding the provision of regularly updated information to road users by radio broadcast etc. It is important that information is accurate, consistent, timely, and helps improve situations. In England, for example, the NRA has contracts with local and national radio stations regarding the provision of strategic-network traffic updates every 15 minutes using various sources. Hessen TMC has addressed this need by having a media desk permanently staffed.

13.4 **Recovery contracts:** private vehicle recovery operators (VRO) may be contracted to remove crashed vehicles. It may be necessary to reach agreement on VRO powers with the police in order to ensure that legal powers and rights are respected, and for performance measures and possible performance incentives to be written in. In the Netherlands, as soon as an incident is reported, a recovery company with a contract covering the area in question is called and sent to the incident spot. This can save a lot of time by not having to wait for the police or TOS to arrive, which can on average take up to 20 minutes in the event of passenger car incidents. The recovery companies train their staff in how to deal with incidents; the Rijkswaterstaat guarantees to cover the costs of false calls.

13.5 **Maintenance contracts:** private firms that directly undertake the maintenance and development of the fixed road infrastructure, including repairs to road surfaces and safety barriers after incidents.

[5] The alternative abbreviation (TCC for Traffic Control Centre) is also used.

## On-line

13.6 **Incident protection vehicles (IPV/ Botsabsorber (NL))** or buffer vehicles act as a conspicuous and robust physical barrier that warns vehicles approaching the scene and constitute the first line of protection for responders and others.

Fig. 12: Collision absorber (NL)

13.7 **Incident screens** have been found to be effective in reducing so-called 'rubbernecking' on both the affected and opposite carriageways, where drivers are distracted by the incident scene or may just feel inclined to proceed more cautiously, causing additional delays and secondary incidents.

Fig. 13: Incident screen (UK)

13.8 **Incident support units (ISU):** the NRA staff or accredited contractors with vehicles and equipment that are needed to set up scene protection and perform some clearance and recovery.

Fig. 14: Incident support unit

13.9 **Laser scanners and GNSS location devices** enable incident scenes to be surveyed more quickly and in considerable detail for subsequent analysis, minimising delay in clearing the scene. Recording scenes by deriving 3D information images from several cameras in different positions is also used.

Fig. 16: Laser scanner & GNSS locator

13.10 **Standardised digital comms:** among responders, such as TETRA (Airwave), or between control offices, such as DATEX II (encoding standard), or towards road users, TPEG (language-independent message standard) can ensure more timely and reliable information and can further harmonisation.

Fig. 15: Weginspecteur pick-up vehicle (NL)

## Off-line

13.11 **Location marker sign:** mainly intended for the public, location marker signs identify the exact location of an incident. Without such signs, the positions reported by people involved in accidents can be unreliable.

## Up/down-line

13.12 **Incident prevention measures** can be divided into **primary** measures, which seek to prevent incidents from occurring in the first place, and **secondary** measures, which seek to prevent further incidents occurring at the scene of an existing incident, e.g. a multiple vehicle collision. In the CEDR TIM survey (CEDR 2010b), several respondents gave detailed answers about the use and usefulness of incident prevention measures (see section 23).

13.13 **Fresnel lenses for LGVs:** thin lenses which can be fitted to the 'passenger' window on LGVs[6], enabling drivers of left-hand-drive LGVs on left-driving roads or vice versa to better see vehicles approaching or passing offside.

13.14 **Statistics collection:** management information and data is important when determining the most cost-effective way to develop TIM capability. This is particularly true for NRAs that are taking their first steps in developing TIM capability. However, significant IT projects involving complex systems and data warehouses need to be approached with caution, as experience has shown that they can be expensive to procure and maintain and therefore difficult to justify when developing business cases.


Fig. 17: TETRA digital radio set

Fig. 18: Location signs and marker post


Fig. 19: Fresnel lens on LGV cab window

[6] 'Large goods vehicle' is standard term, not to be confused with 'light goods vehicle'.

## 14 Critical timeline of responses

### Duration of incidents and response phases

14.1 The survey of CEDR members yielded information about timelines for several countries that record statistics in varying detail. The available data is visualised in Fig. 20, where the phases of the incident management cycle defined above are shown schematically. Individual cases are positioned according to their total durations (assuming no overlaps between phases). The split between their phases is highly variable, and the figure reflects only minimum, average, and maximum as shown.

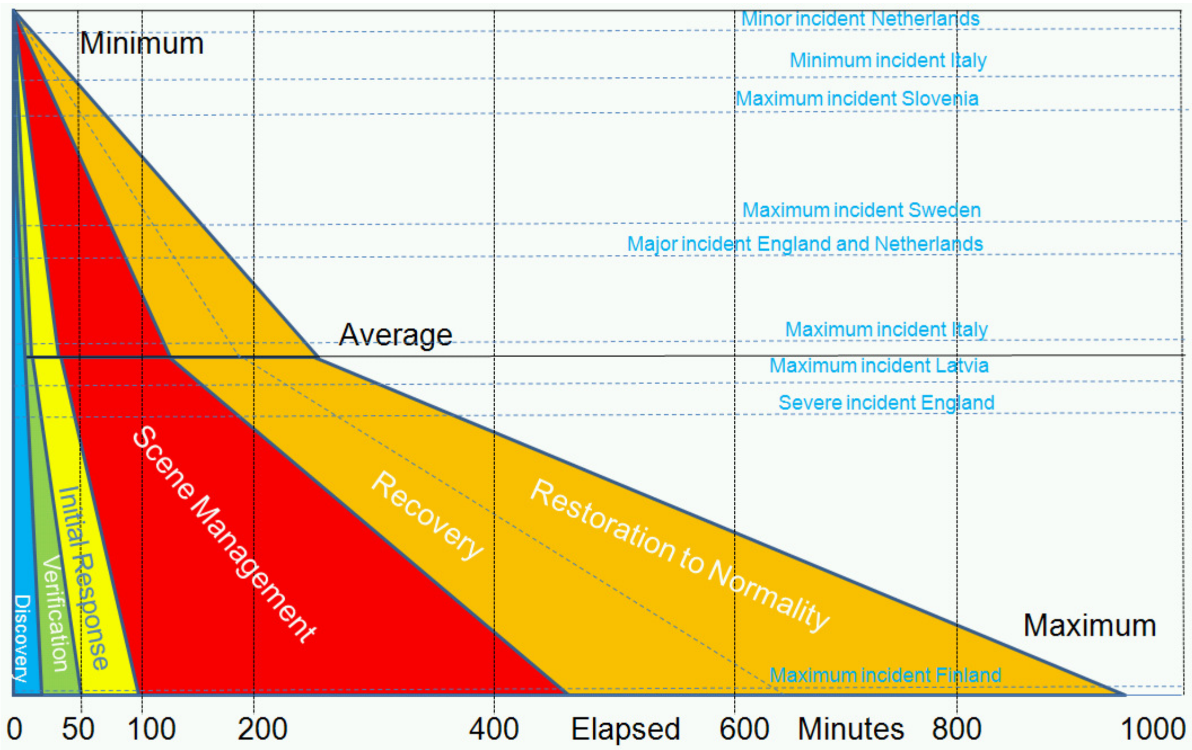



Fig. 20

14.2 ***Incident durations*** are highly variable, with the scene management phase being the greatest variable. There is a divide between countries with densely trafficked and monitored strategic networks, such as England and the Netherlands, and more sparsely populated countries such as Finland. Fig. 20 highlights the distinction between the three initial ***emergency response phases*** and the following ***management phases***, which involve different capabilities. The emergency response phase is relatively short, but can determine the success of management of the incident. In particular, quick detection and initial response may save lives and reduce the risk of secondary incidents. After that, incident duration depends on the circumstances. However, efficient management can ensure disproportionately high benefits, such as reduced congestion and overall delay and also benefits from an appropriate and well-planned initial response.

14.3 The split between ***recovery and restoration to normality*** can be ambiguous, even though their definitions are different. In many cases, figures for recovery and restoration to normality were not disaggregated when reported. However from available data, during the recovery phase, the primary source of delay is loss of capacity associated with debris and emergency treatment, and the primary focus is to clear the carriageway. During the restoration to normality phase, the primary source of delay is the queued traffic itself and the primary focus is to get it moving again.

## Examples of incident timelines

14.4 Examples were provided by the Netherlands. In each case, the critical path that determines the typical minimum or maximum incident duration is marked by the red arrows. As Fig. 24. illustrates, handling time has been improving, and further improvement is anticipated.

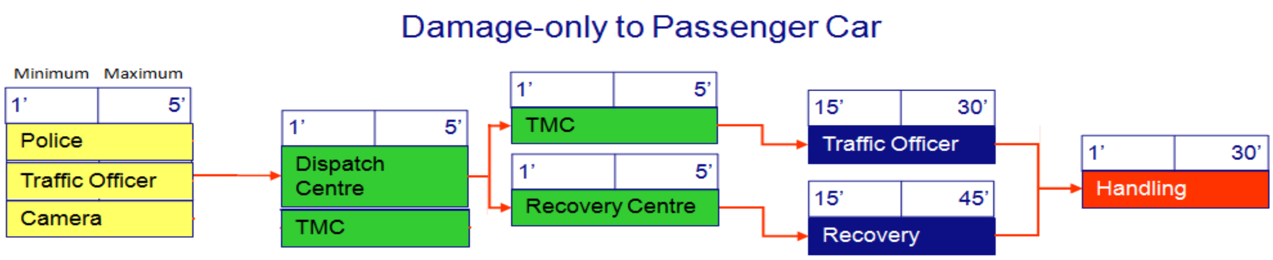



Fig. 21

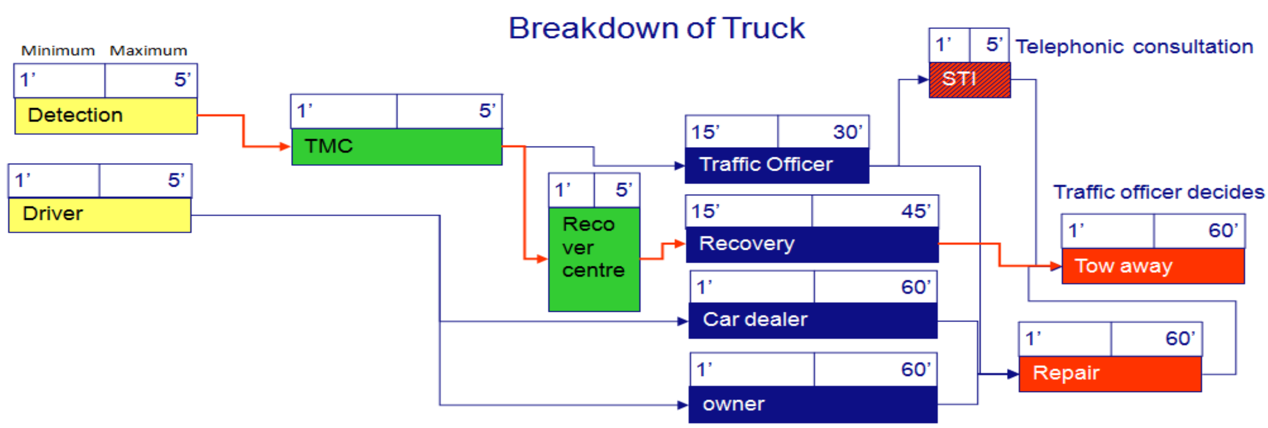



Fig. 22

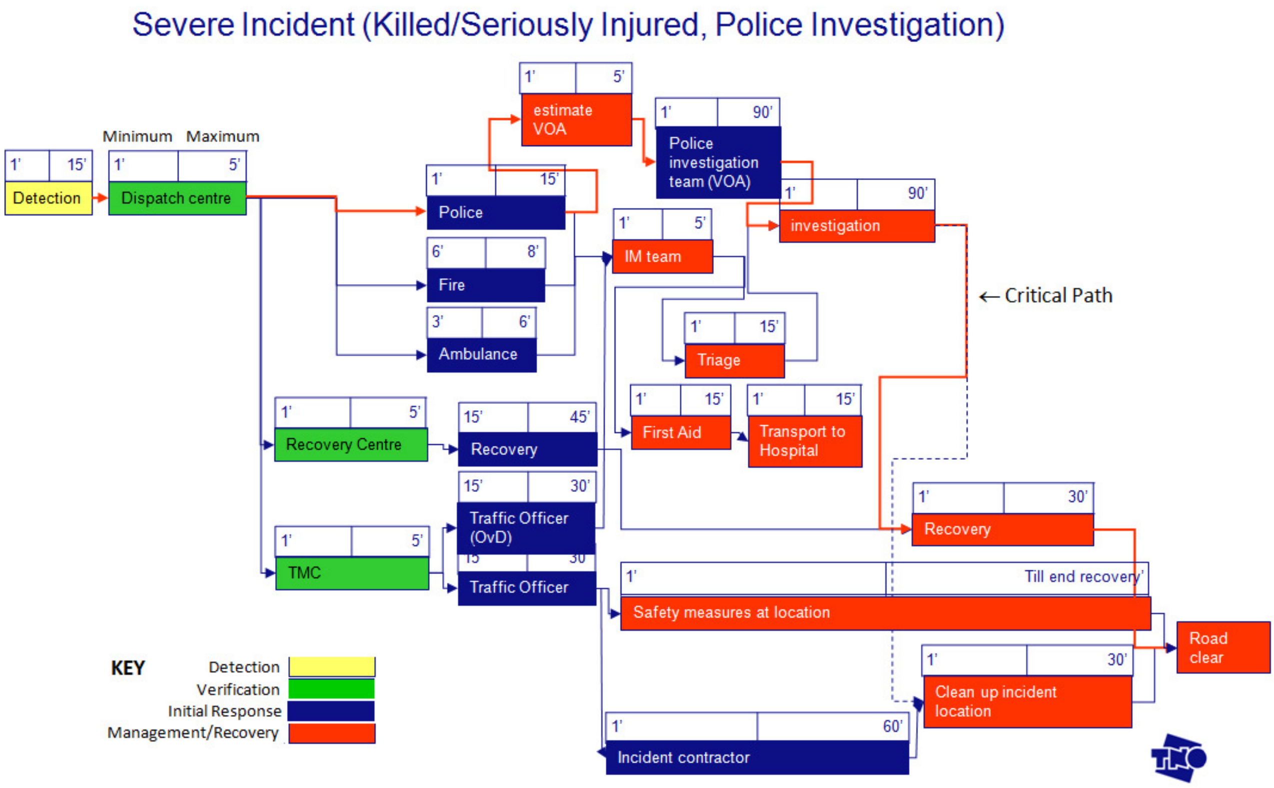
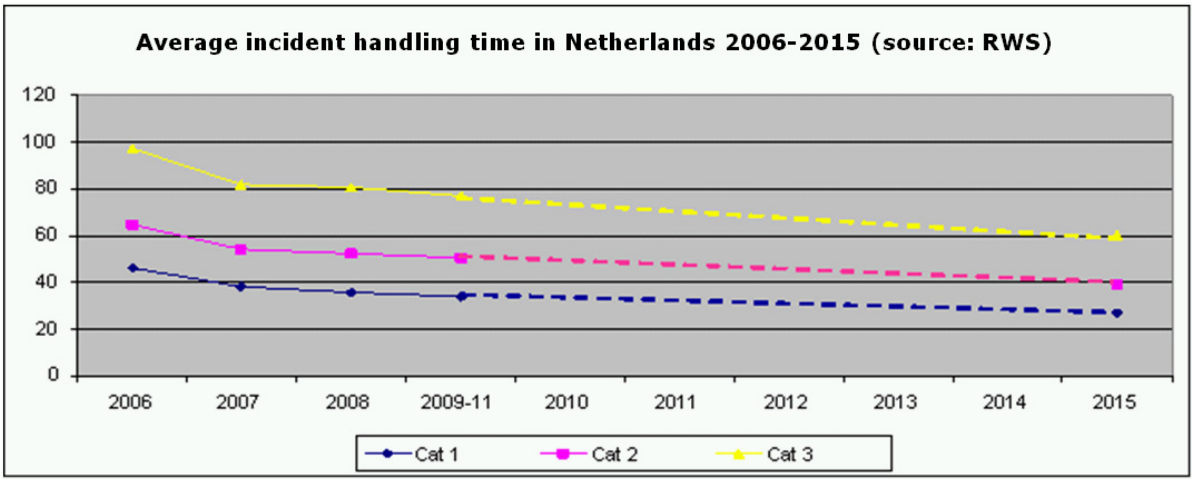



Fig. 23




Cat 1: Breakdowns with cars: standard handling time = 30 minutes;
Cat 2: Truck breakdowns and accidents involving cars without injury: standard handling time = 60 minutes
Cat 3: Accidents involving trucks and all accidents involving injuries: standard handling time = 90 minutes

Fig. 24

### Optimising response timeline: proactive versus reactive

14.5 The 'cycle of phases' model does not emphasise that phases can overlap, although this can be inferred from the examples above and is explicit in linear models such as in EasyWay (2009b). However, in addition to just letting phases overlap, appropriate timing may be beneficial, with information and dispatch being timed so that responders come into play at the optimum moment. Fig. 25 compares a 'reactive approach' and a 'proactive approach'. Proactive dispatch may be used particularly to launch initial response during the verification phase and initiate recovery and restoration actions during the scene management phase. With the proactive approach, rather than just waiting for completion of the present phase, the next phase is anticipated. This leads not only to better use of resources but also to reduced overall incident duration and the safety benefit of reduced exposure of responders and the public.

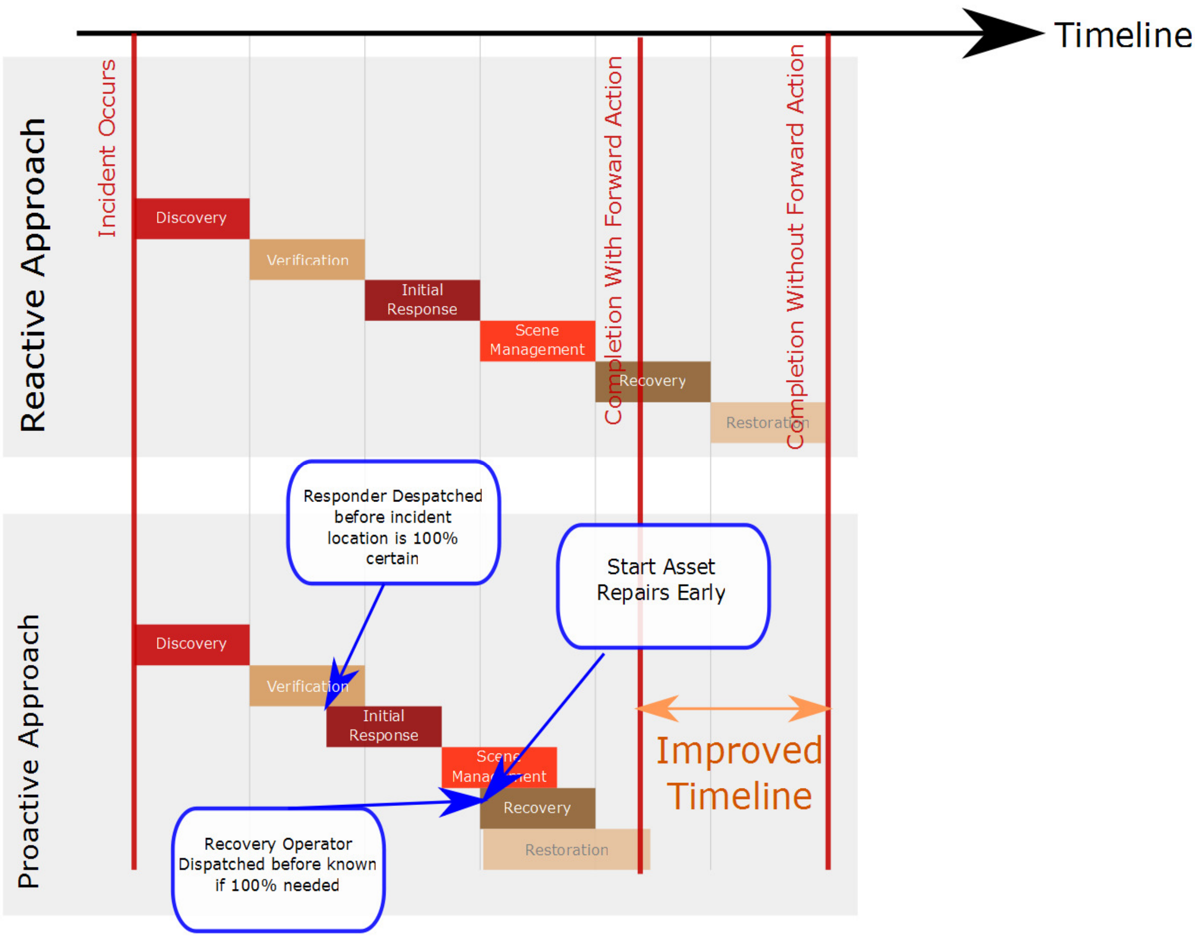



Fig. 25

## 15 Experience in scene management and recovery

### Facilitating access to the incident scene

15.1 Recovery and restoration to normality are two of the phases within the incident management cycle that, if overlooked, can have a significant impact on the incident's overall management. The two most common reasons are:

- a failure to notify vehicle recovery operators and other contractors at the right time;
- access to the scene is restricted, especially for those providing specialist recovery equipment.

15.2 The issue of timing was addressed in the previous section in terms of overlaps between response phases. Although contractors should be contacted during the verification or scene management phases, their attendance at the incident scene can be delayed by congestion not only on the motorway but also on the surrounding road network.

15.3 In many cases, early notification will help responders access incident scenes. This is largely due to the fact that the earlier they are notified, the sooner they can prepare and agree their plans with the responder and the TMC, which includes identifying the most efficient way to reach the incident scene.

15.4 Congestion can sometimes be avoided by driving on a hard shoulder or another abnormal path such as in the 'wrong' direction on the opposite carriageway. However, recovery contractors do not normally have the legal authority to do this. Those services that do have such authority—such as the police and fire and traffic officers—should be prepared to provide escort for essential recovery vehicles. This should be considered as part of the access component of TIM readiness.

15.5 The escorting of contractors can be resource intensive, and could take police, traffic officers, or other emergency responders away from other important traffic management duties. For this reason, the incident commander should always consider the priorities at the incident before releasing any resources to carry out escorting duties. Whether permission can be given to a recovery contractor to proceed unescorted will depend on the situation and the legal position. However, these kinds of questions can be addressed through debriefings and exercises (see section 17).

# 16 Special incident management techniques

16.1 In addition to the immediate actions described above, some techniques can be used to assist incident management by improving access to the scene or managing queues, provided that the necessary staff, equipment, and control systems are available.

16.2 This section presents several advanced examples of traffic management at incidents. There are numerous fundamental concepts. This manual is not intended to be a primer in traffic management; instead, the examples provided are there to demonstrate the approaches that can be used to set up a traffic management system that is designed to smooth the flow of traffic and create a safe environment for the responders.

## Rolling block or convoy control

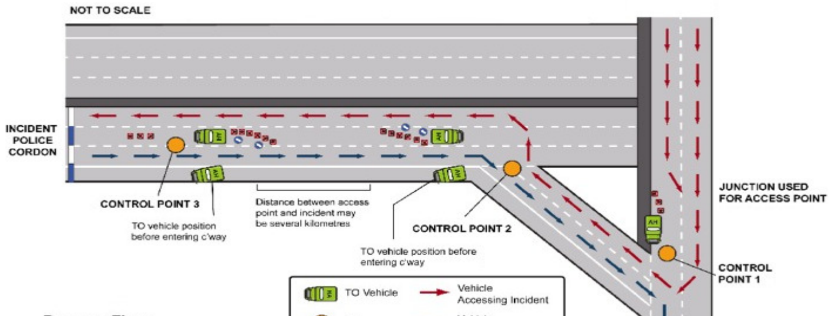
16.3 This technique is used in those cases where the aim is to create a traffic-free 'window' of a specific length, without actually stopping all traffic. It can be set up by a squadron of control vehicles (police cars, traffic officer vehicles, LGVs carrying 'stop' signs etc.). It is of course necessary to start the rolling block several kilometres upstream of the place and time where the 'window' is needed, so it is often used as part of a planned operation, such as rapid installation of infrastructure.

## Hard shoulder running

16.4 Some major incidents, such as those involving LGVs, can block all the running lanes on a highway. In these cases it is sometimes suitable to use the emergency lane (or hard shoulder) as a temporary area for running traffic a short distance past an incident, before routing the traffic back onto the main highway. Use of this method requires coordination between incident responders to ensure that access for newly arriving responders on the emergency lane is not impeded.

## Reverse flow

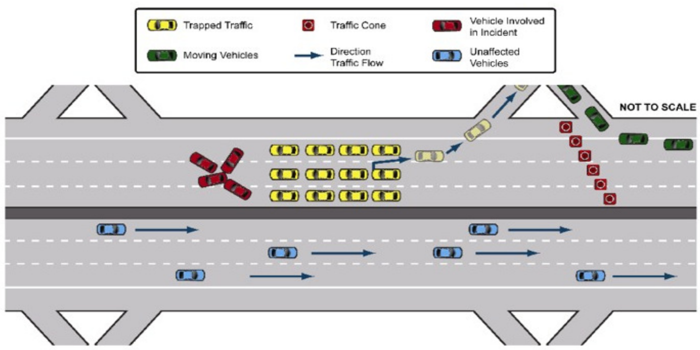
16.5 This procedure enables emergency responders to reach an incident scene when it cannot be accessed from behind. It allows vehicles to approach the scene safely and in a structured manner from upstream, turning the carriageway temporarily into a two way road.




Reverse Flow
3 Lane Carriageway Using Slip-Off as Access (with Hard Shoulders)
(Continental driving side convention)

## Rearward relief

16.6 This technique enables trapped traffic on a motorway to be turned around in a controlled way to travel in the 'wrong' direction down the carriageway to a point where it can be directed off the carriageway via an upstream access slip road, or exit slip road if local junction layouts dictate.




Rearward Relief (Continental driving side convention)

## 17 Training and exercises

Crucially, incident management depends on the coordination of a number of different players who may have different statutory responsibilities and organisational structures. Multi-responder debriefings, meetings, and exercises can be an efficient way of developing and maintaining inter-responder coordination and cooperation.

17.1 Many countries hold debriefings, training sessions, and exercises, which can range from table-top simulations to major live multi-responder exercises. Organisations involved may include:

- the national road authority
- the regional road agency
- a traffic management centre
- the highway owner, operator, or contractor
- local authorities
- the police
- the traffic officer service
- the fire and rescue service
- the ambulance service (including air ambulances)
- the Red Cross or other voluntary service
- vehicle recovery operators

Fig. 26: A debriefing and a table-top exercise

17.2 Live exercises may be appropriate to investigate, test, or verify:

- command, control, and communications
- specific scenarios such as severe weather or a chemical spill
- new equipment or techniques
- procedures at 'live' sites such as tunnels

17.3 Live exercises are likely to be expensive, not only in terms of material but also in terms of the time needed by participants to travel and be on site, which also represents a cost, whether it be a 'live' site, where closures or diversions have to be set up, or an airfield or test track that have to be hired. NRAs with little experience in running exercises might initially get best value for money if they can attend or participate in exercises in other countries with more experience.


Fig. 27: Live exercise scenes and scenario

## Examples of exercises and debriefs

17.4 Many countries conduct debriefings and exercises at many levels, as indicated above. However, it may be useful to provide links to actual examples, even though these may represent the activities, experience, and conclusions of only a few countries which practice intensive incident management.
Some examples from the English Highways Agency are given, as they are readily accessible. The Dutch Rijkswaterstaat also publishes bulletins at
http://www.rijkswaterstaat.nl/kenniscentrum/magazines/wegeninfo/

| **Exercise** | **Date** | **Scenario** | **Link** |
|---|---|---|---|
| Valentine | 02/08 | Major truck crash | http://www.highways.gov.uk/business/18042.aspx |
| Extend | 10/08 | Flooding procedures | http://www.highways.gov.uk/business/20588.aspx |
| Poppy | 11/08 | Investigation & diversion | http://www.highways.gov.uk/business/20928.aspx |
| Goldie | 02/09 | Command structures | http://www.highways.gov.uk/business/22703.aspx |
| - | 04/09 | Severe weather exercise | http://www.highways.gov.uk/business/23377.aspx |
| Tiger | 04/09 | Planning & communication | http://www.highways.gov.uk/business/23367.aspx |
| Diamond | 06/09 | Multi-agency response | http://www.highways.gov.uk/business/24017.aspx |
| Firecracker | 11/09 | Tabletop: recovery services | http://www.highways.gov.uk/business/25829.aspx |
| Hermes | 01/10 | Tabletop: resilience | http://www.highways.gov.uk/business/26373.aspx |
| Gridlock | 05/10 | Tabletop: extensive congestion | http://www.highways.gov.uk/business/27107.aspx |
| Compitum | 07/10 | Multi-agency in snowfall | http://www.highways.gov.uk/business/28499.aspx |

17.5 Further information on exercises and findings and many aspects of incident management can be found in the Highways Agency's regular TIM Bulletin (send an e-mail to TIMBulletin@highways.gsi.gov.uk for information about signing up). The articles and debriefs listed below may be of interest:

| **Date** | **Scenario** | **Link** |
|---|---|---|
| 09/09 | Rearward relief & reverse flow methods | http://www.highways.gov.uk/business/25126.aspx |
| 12/09 | Bitumen tanker spillage debrief | http://www.highways.gov.uk/business/26126.aspx |
| 01/10 | Bridge strike debrief | http://www.highways.gov.uk/business/26386.aspx |
| 02/10 | Managing incidents at road works | http://www.highways.gov.uk/business/26716.aspx |
| 06/10 | Managing spillages | http://www.highways.gov.uk/business/28046.aspx |
| 07/10 | Releasing trapped traffic at Incidents | http://www.highways.gov.uk/business/28492.aspx |
| 08/10 | Investigating fatal incident at bridge | http://www.highways.gov.uk/business/28641.aspx |
| 08/10 | Tunnel resilience to Incidents | http://www.highways.gov.uk/business/28647.aspx |
| 09/10 | Emergency diversion routes 'embedment' | http://www.highways.gov.uk/business/28932.aspx |
| 10/10 | Facilitating access to incident scenes | http://www.highways.gov.uk/business/29312.aspx |
| 10/10 | Thames River Dartford crossing incidents | http://www.highways.gov.uk/business/29313.aspx |

## 18 General performance indicators

It is rarely possible to measure traffic management interventions against fixed benchmarks. However, performance indicators can be monitored to identify trends of improvement.

18.1 The data most commonly acquired by NRAs active in incident management are listed in the table below.

| Measure | Description |
| --- | --- |
| Vehicle flow/congestion | Measured using loops and cameras to estimate the numbers of vehicles impacted by congestion. Usual unit: vehicles per hour. |
| Journey times and delay | Measured using loops and ANPR cameras to detect or estimate travel time or lost time caused by congestion. Usual unit: vehicle-hours per km. |
| Response times | Measured using incident responder reports or automated dispatch systems. Often specified in responder or vehicle recovery contracts. |
| Safety | Monitored using reporting processes and used to decide where to put new safety equipment. Usual unit: numbers killed or seriously injured per annum. |

18.2 These indicators provide information about the performance of an NRA's incident management approach. More detailed indicators that look at specific aspects of operational performance can provide an insight into new areas for improvement. Care should be taken with these indicators as they can be misleading or subject to unanticipated cause-and-effect relationships.

18.3 The CEDR report from task 11 (CEDR 2010a) indentified the value of using iterative learning loops to continually refine and enhance the use of indicators, which is equally relevant in incident management. When combined with fit-for-purpose information technology, this can result in better situation awareness and more effective management.

# APPENDIX B

## Concepts for effective traffic incident management

For definitions and references see Appendix D

## 19 International best practice in incident management

### Europe: EasyWay's TIM Guideline

19.1 EasyWay is a project on the Europe-wide harmonised deployment of ITS on main TERN corridors. It is driven by NRAs and operators with associated partners including the automotive industry, telecom operators, and public transport stakeholders. It has identified a set of necessary ITS services that can be deployed under the varied headings of traveller information, traffic management, and freight and logistic services (http://www.easyway-its.eu). EasyWay's project and study groups have developed 19 guidelines.

19.2 EasyWay's 'Guideline for the deployment of incident management' (EasyWay 2009b) defines several incident management elements or components at three different levels of service, as summarised in the table below, where the terminology has been modified to agree with that used in the rest of this report. Levels of service apply to individual components and do not necessarily define an overall level of incident management service, although components may be linked. This may be considered a generalised way of defining roles in TIM. As with the 3D 'TIM Space' diagram (see main report and Appendix C), one can envisage development paths through the matrix. The guideline includes a more detailed matrix describing the elements and case studies from three countries.

| Component of incident management | Level of service | | |
|---|---|---|---|
| | Basic | Enhanced | Intensive |
| Coverage of IM | Critical sites and/or critical periods | Selected parts of the TERN during specific times of the day | The whole TERN, all day, every day |
| Communication | Phone based | Some dedicated systems | Fully dedicated systems |
| Cooperation and coordination | Individual systems, procedures, education, and training | Partly common systems, procedures, education, and training | Fully common systems, procedures, education, and training |
| Discovery and verification | Human sources<br>112 calls or ERT<br>Road and exit location signs | Camera surveillance<br>Traffic surveillance<br>Location signs within 500 m | Automatic incident detection and camera display<br>Full coverage location signs |
| Exercises | None | Table-top and meetings | Live multi-responder exercises |
| Evaluation | Individual evaluation<br>Individual criteria | Individual evaluation<br>Common criteria | Common evaluation<br>Common criteria |
| Road authority involvement | Traffic information on traffic radio and other media<br>Recovery service | Traffic information and regulation at the scene | Traffic management plans (TMPs) for rerouting traffic officer service |
| Responder coordination | Ad hoc, using existing public emergency services | Police led, other responders on call | Traffic officer service and control centres |
| Responder education and training | Ad hoc | Guidelines | Formal training and certification |
| Road user instruction | Instructions given to road users when making a emergency call | Pre-trip information on road user behaviour via the web | Pre-trip advice on road user behaviour in leaflets (to put in the car) |

## TIM in the United States of America

19.3 Although many countries outside Europe have developed incident management practices (including Australia, which contributed to the CEDR survey), the USA is of particular interest for three reasons:

- the Federal Highways Administration (FHWA) has been very active in formulating and publishing best practice guidelines by bringing together a number of stakeholders;
- the FHWA regularly seeks information from other countries and has undertaken 'SCAN' study tours of incident management and other practices in Europe;
- the federal states maintain a high degree of autonomy within the federal structure, which means that the FHWA works within a framework of federally adopted measures, general best practice advice, and examples of state or other local practice.

19.4 Over several years, the FHWA has worked with other organisations to form the National Traffic Incident Management Coalition (NTIMC) and develop a National Unified Goal (NUG) for TIM hinging on three high-level goals (FHWA 2010b):

- responder safety
- safe quick incident clearance
- prompt reliable and interoperable communications

19.5 The FHWA identifies broadly the same issues as European sources, in particular 'cross-cutting challenges', or 'horizontal' components such as inter-responder coordination and communication, and 'vertical' phases of response (see TIM Grid in Appendix A). However, it emphasises the role of traveller information, including information that is made available via the 511 phone system, websites, and broadcast media 'to enhance the provision of traveller information to motorists who are primarily off-site in an effort to reduce traffic demand at the incident scene'. The provision of traveller information in Europe is broader than incident information and therefore goes beyond the specific remit of this task. Nevertheless, it is addressed by CEDR's task group 12 on traffic management.

19.6 Problems identified include:

- inconsistent notification of incident responders
- inaccurate incident reporting and location
- slow detection
- dispatcher overload
- indirect communication and unnecessary or inappropriate calls for attendance

19.7 Broadly the same remedies as in Europe are highlighted, namely:

- monitoring systems (CCTV)
- one-site verification by responders
- frequent location marking and/or enhanced automated position
- automatic collision notification
- having plans in place to deal with different types of emergency

19.8 There is also an emphasis on adequate towing provision and contracts and quick clearance, a significant aspect of which is the existence in some states of driver removal and authority removal laws, which allow vehicles or casualties to be removed quickly while complying with legal requirements for investigation and protecting responders from any ensuing legal liability.

19.9 The US federal government has adopted an Incident Control System (ICS), which is an 'on-scene command and control protocol that lends consistency to TIM actions, clearly defines command, improves interdisciplinary communication, and more fully utilises resources' relying on a 'unified command concept whereby management responsibility is shared for the incident'. Many European countries have developed similar systems, but as has been made clear elsewhere in this document, a single European prescription at this level is probably not practical.

19.10 Conversely, in some respects, the USA may be behind Europe, as the FHWA feels it necessary to go into some fairly basic topics including high-visibility clothing, vehicle markings, on-scene emergency lighting and traffic control, and hazards caused by abandoned vehicles. Recently there has also been criticism of traffic safety practices and strategies in the USA, both by a committee of the National Research Council and by a former member of the National Transportation Safety Board (NTSB), see ITS International (2010).

19.11 Another issue identified in the FHWA report is inadequate life-cycle costing of technology. This may not be a problem in European countries that already possess highly developed technology-based systems, but it could be a problem for countries thinking of introducing new ITS technologies, especially where these 'leap-frog' over more mature conventional approaches. It may be an inherent problem where failure rates, mission creep, and other unforeseeables cannot easily be costed, apart from the difficulty of linking benefits to specific measures when used in combination with others.

19.12 Nevertheless, there may be much to learn from US practice in terms of frameworks of inter-agency cooperation, cross-border coordination, local examples of best practice, and quick collision investigation and clearance techniques that take account of legal and personal sensitivities. These include advanced scene recording—known in the USA as Total Station Surveying Equipment (TSSE)—corresponding to Laser Scanners and 3D image recording as used in Europe to accelerate investigations, and allowing emergency medical services (EMS) to certify deaths rather than waiting for a coroner. This is beyond the scope of this task as the relevant laws are likely to vary between European countries and would be difficult to modify except at national level. However, it could be addressed in a more general context.

19.13 The nearest equivalent to a traffic officer service in the USA are safety/service patrols (FHWA 2009a,b), whose remit is based on the NUG and which 'frees police and other emergency response personnel to perform the activities associated with their primary missions'. Full-function safety/service patrols (FFSSP) are described as 'a new generation of first responders'. SSP functions include traffic control and scene management. The guide indicates that SSPs may stop traffic and 'may have some special driving privileges and exemptions that are not extended to the general public', but points out that they 'in general, do not have the same exemptions to traffic laws given to police, fire, or EMS response units.' SSPs vary as they are organised by the individual federal states.

19.14 It is not entirely clear how much of the FHWA material is directive and how much is optional advice. The impression is that it is a set of principles that represent common sense and good practice, written in a way that recognises the likelihood that cultural change, pockets of localised best practice, and pressure from government organisations to improve TIM capability whilst reducing costs will gradually lead to standardised practices across the country as and when such practices are widely recognised to be sensible, valuable, and cost effective.

## 20 Response time targets

20.1 Many countries have formal agreements or contracts specifying target or maximum response times, either of the NRA or public services or private contractors. Other countries may have less formal targets. Examples are given below, including for some from non-European countries.

| Country | Circumstance | Response time (minutes) |
|---|---|---|
| Belgium-Flanders | Urban | 15 |
| | Rural | 20 |
| Denmark | Contracted | 30[7] |
| England | Traffic officer service - high-priority section | 15 |
| | Traffic officer service - heavily trafficked | 80% within 20 |
| | Traffic officer service - lower-priority section | 25 |
| | Incident Support Unit on scene minimum | 20 |
| | Incident Support Unit on scene maximum | 90 |
| | Recovery[8] of light vehicle | 30 |
| | Recovery of goods vehicle | 45 |
| | Clearance | 80% within response+30 |
| | Local broadcast radio traffic updates every | 15 |
| Germany | Response time legal obligation | 90% within 8–12 |
| Netherlands | Ambulance | 15 min (95%) |
| | Fire | 10 min |
| | TOS high-priority IM | 15 min (80%) |
| | TOS IM | 30 min (80%) |
| | Recovery | 20 min (90%) |
| | Goods vehicle | 45 min |
| Singapore | Detection (average) | 3 |
| | Response (average) | detection+8 |
| USA | Clearance minor incident – FHWA target | 30 |
| | Clearance major incident – FHWA target | 90 |

20.2 As a densely urbanised area, Singapore is a special case. The figures for the USA, on the other hand, may be typical of major highways in more sparsely populated advanced countries. When compared with incident data from the CEDR survey, all targets fall within the average time for completion of scene management. Inevitably, however, most incidents last much less than the average because of the skewing effect of a few incidents of long duration.

20.3 A crucial element of response is related to the protection of the scene from secondary accidents and saving the lives of seriously injured casualties, as described in the next section.

[7] The target was formerly 20 minutes, but was relaxed because it could not be practically achieved.
[8] Meaning recovery of a vehicle by a recovery operator, not completion of the recovery phase

## 21 Safety, casualties, and causes

An important part of dealing with any emergency is to act in such a way as to make the situation better rather than worse. This may seem obvious, but many actions which seem obvious in hindsight have actually been learned through hard experience. Time is often a critical factor. Not only responders but also the public need to be aware of critical safety and life-saving actions.

21.1 As Fig. 28 shows, accident rates across Europe (and other OECD countries) vary greatly. Fig. 29 suggests that although accident rate and severity may be anti-correlated, this may just reflect an underlying common factor, such as higher speeds on more developed road systems.

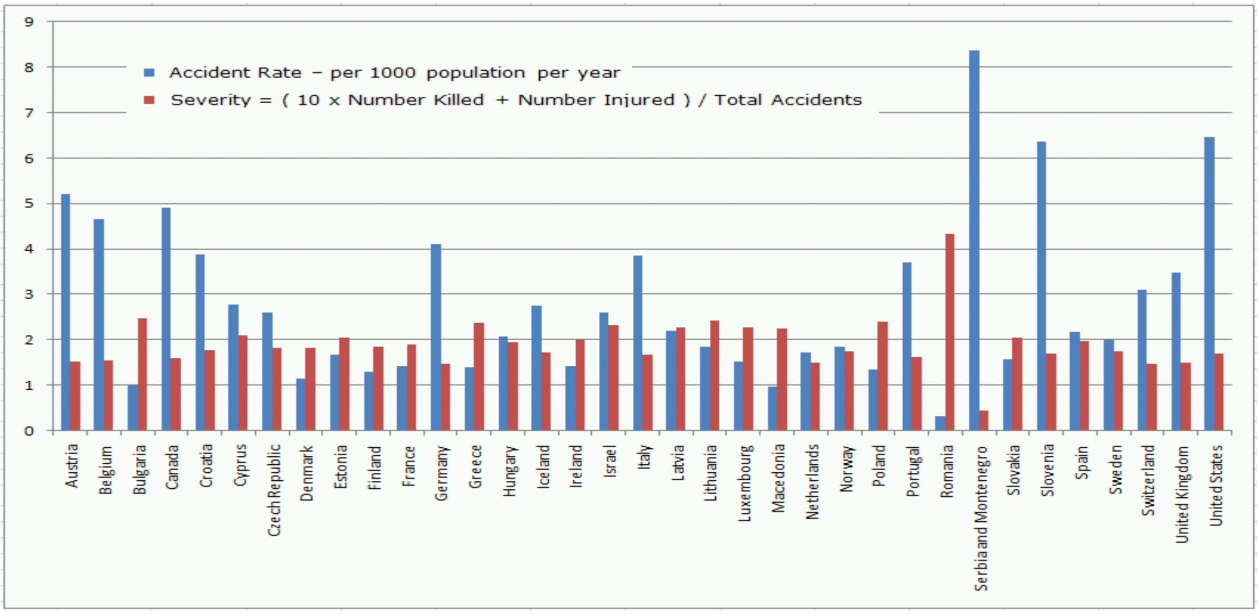



Fig. 28

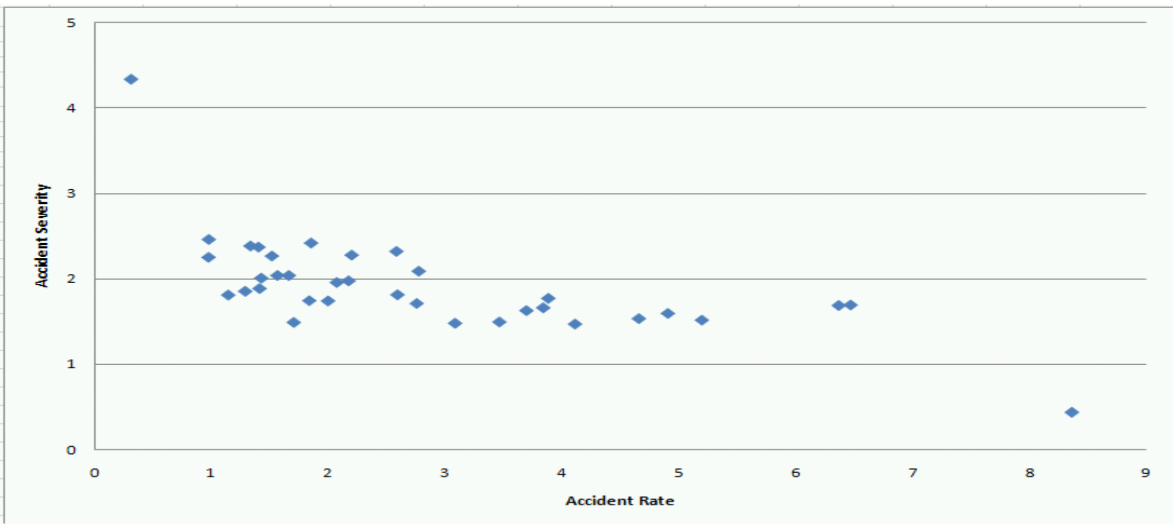



Fig. 29

## Protecting the scene as soon as possible

21.2 **Persons who are able to leave their vehicles should do so and move off the carriageway**, up an embankment if there is one, or to a safe distance downstream of protection vehicles. There have been many cases of stationary vehicles being struck at high speed even on the hard shoulder. Because of the high impact speed, such ***secondary accidents*** are usually very serious.

21.3 **The accident scene should be physically protected.** This can be done by placing a high-visibility vehicle or other barrier with suitable hazard warnings upstream of the scene. The vehicle should be placed at an angle pointing towards the nearside with its steering wheels turned towards the nearside. If struck from behind, it will be not be shunted into the incident scene and will tend to deflect the striking vehicle away from the scene.

21.4 **The accident scene should be protected by warning signs** if possible. This is necessarily an action to be carried out by the TMC, if there is one. If variable message signs or speed limits are available, these can be used; queue detection systems may automatically set low speed limits. Vehicles involved or passers-by may show flashing hazard lights. In poor visibility, warning signs are particularly important since red brake lights can be confused with rear lights and traffic speed misperceived.

## The 'platinum 10 minutes' and 'golden hour' for saving lives

21.5 **Emergency response time is a critical factor when it comes to an injured party's survival chances** following an incident. The British Association of Chief Police Officers (ACPO) has identified the first 'platinum 10 minutes' as being the critical time within which a seriously injured patient should be treated and/or removed from the scene of the incident (unless trapped), while the 'golden hour' is the window within which treatment must commence in order to avoid the risk of the development of brain and organ damage after internal injury. The 'platinum 10 minutes' are made up of:

- assessment and primary survey (1 minute)
- resuscitation and stabilisation (5 minutes)
- immobilisation and loading for transport (4 minutes)

## Hazardous materials and abnormal loads

21.6 Many serious tunnel fires have occurred when hazardous materials carried by an LGV have ignited. Generally speaking, even if not initially involved in the incident, hazardous materials can cause an escalation through fire, poisoning, or damage to infrastructure and in particular to the road surface. It is therefore essential to identify such hazardous materials at an early stage.

21.7 If there is no one on the scene who is qualified to assess the hazard, there should be a contact person with these qualifications, e.g. the operator of the vehicle. Managers need to be made aware of the scale and the nature of the problem, e.g. how heavy is the LGV, is it on its wheels and towable, is access or removal obstructed by other vehicles or debris, is the situation aggravated by weather such as high winds, are animals on the loose etc.?

21.8 Much of this is 'common sense', but where the unexpected can occur, it is advisable to follow a procedure. Each country is likely to have its own procedures, and harmonised procedures are being defined by the EC. Safety in tunnels is already the subject of a directive. Typically, a hazardous load will be identified by a HAZMAT marking on the vehicle or a database accessible with the vehicle's registration number. See also EasyWay Guidelines (EasyWay 2009a).

## eCall and 112

21.9 eCall is a system whereby a GSM phone in the vehicle is linked to sensors, which in the event of a crash of sufficient severity trigger the phone to make an automatic emergency call (112, 911, 999, or equivalent) to a public safety answering point (PSAP) either directly or via a third-party provider. This call should convey digitised information about the vehicle and its condition and should permit voice communication with the occupants if they are capable of such communication. It is estimated that eCall can reduce response time by 3 or 4 minutes.

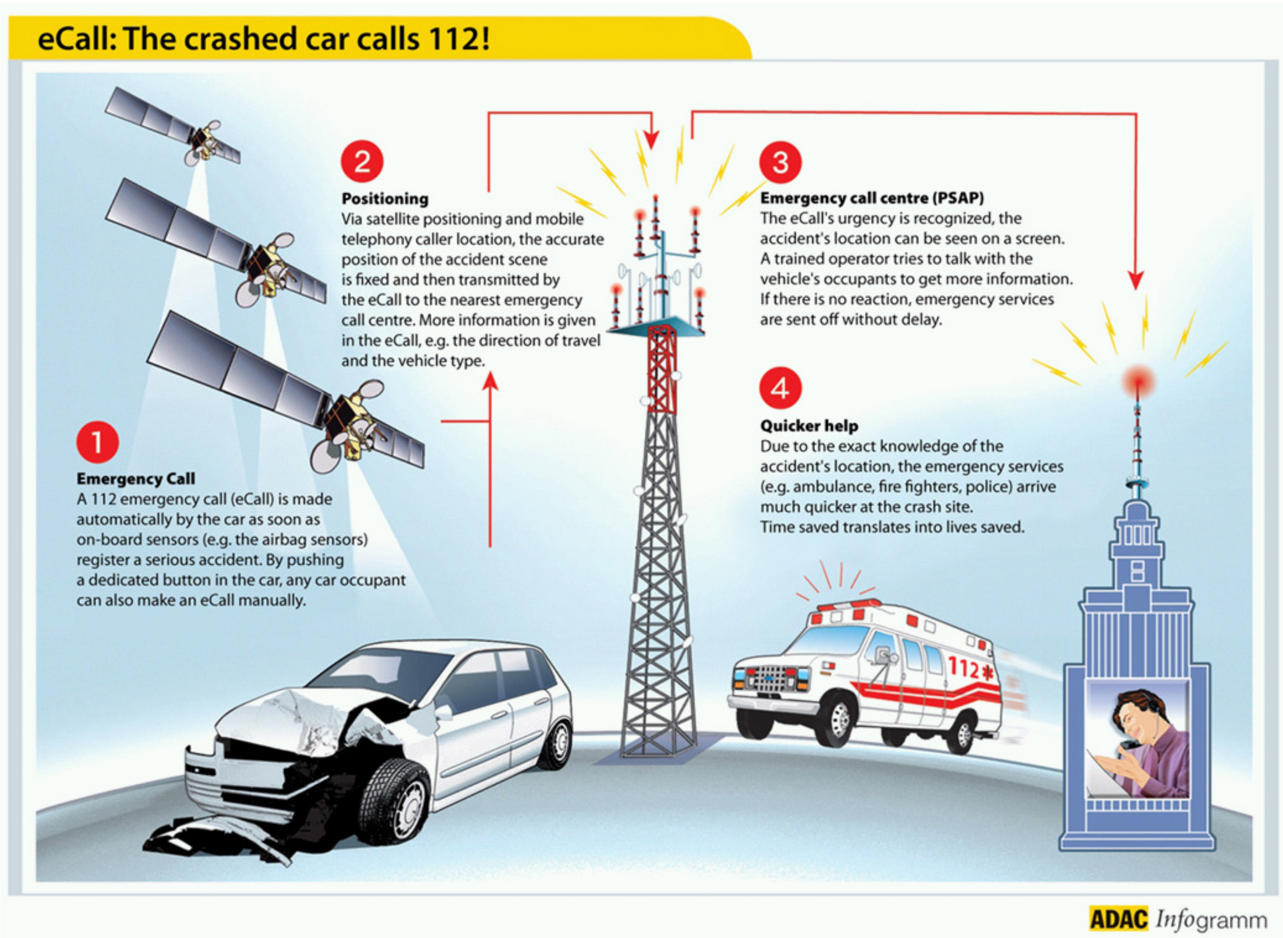



Fig. 30

21.10 Protocols are being developed under EC sponsorship. However, take-up of the system is not currently guaranteed. The eCall plan is for a 1-year trial and implementation in all EU countries by 2014. Every new car will then have to be fitted, and every country will have to provide PSAPs.

However, interest in the system varies. Currently the business case in the UK is considered weak (Stevens and Hopkin 2010); France has its own system. eCall requires strategic cooperation outside NRAs. TISPOL has signed up, but 112 has not even been implemented yet in every country, nor does a standard exist.

### Recording and investigation

21.11 In most countries, the collection of ***evidence***, including statements from those involved and any witnesses as well as a reliable description of the incident scene, the vehicles involved, the course of events, and any contributing factors is necessary for insurance purposes. It is also often a legal requirement. It is a well-known fact that witnesses can be unreliable. Moreover, the unexpected nature of incidents means that without some objective record, it may be impossible to establish the full story.

21.12 The ability to get an objective record of events obviously depends on the available infrastructure and equipment. Ideally, ***CCTV images*** should be stored long enough to be available as evidence. In some TMCs, images may only be stored for 30 minutes. However, this is long enough for operators to secure them in the event of an incident that takes place on the part of the network covered by the TMC. ***Laser scanners*** can make a detailed and precise 3D record of the scene including, for example, skid marks, which can subsequently be examined to establish vehicle speeds and trajectories.

21.13 The cost of delay on a busy motorway or freeway is such that in some countries or states there is a ***quick clearance policy***, i.e. a policy of clearing the road as quickly as possible. This may have to be addressed at state policy level because of the legal and financial protection due to participants if there is a risk that evidence may be lost. The police are also likely to have an opinion on quick clearance.

21.14 The more sophisticated the recording method, and/or the more assertive the method of incident management, the greater the need for understanding, reliable communication, and cooperative agreements between responders, and the greater the need for well-planned and robust procedures.

# 22 Economic cost and congestion

## The economic cost of fatal and injury accidents

22.1 The European Transport Safety Council's figures on fatal, serious, and slight injuries in road accidents throughout Europe (ETSC 2007) are given in the table below. There is significant variation between European countries in the valuation of the costs associated with serious incidents, ranging from a low of €55.8K in Portugal to a much higher value of €2.71M in Norway. There is also significant variation in the way that serious injury incidents are defined across Europe. Nonetheless, typical figures are shown in the below table.

| Severity | Annual number | Reported | +Unreported | Cost of each (2002) |
|---|---|---|---|---|
| Fatal | 41600 (2005) | 2.8% | 1.3% | €1.3–2.7M[9] |
| Serious | 330K (est.[10]) | 22.5% | 14.4% | €230K (est.[11]) |
| Slight | 1.1M (est.[10]) | 74.7% | 84.3% | €23K (est.[11]) |

22.2 Overall, however, the annual cost of fatal road accidents, approx. €83 billion, is similar to the cost of reported serious accidents, around €76 billion. At around €25 billion, the overall cost of reported slight injuries is much lower (it is not known whether unreported slight injuries are less severe or whether the numbers include non-injury accidents. Figures for slight injury incidents do not take the cost of congestion into account).[12]

## The economic cost of congestion

22.3 Most countries will have adopted values for time and delay. Although these vary according to traffic composition and journey purpose, there may be an official average or reference value that allows the economic cost of congestion caused by an incident to be estimated.

22.4 In the UK, the average value is around £13.40 (€15.80) per vehicle-hour (DfT 2010/2011), and in the Netherlands around €16. In the Netherlands, traffic accidents and delay are estimated to cost €10.4–13.6 billion/year of which delay alone costs €2.8–3.6 billion/year. Delay attributable to incidents amounts to 12% of this, i.e. €336–432 million/year. It is estimated that TIM avoids €100–130 million in social costs compared to an annual investment of €27 million, implying a high Benefit/Cost Ratio (BCR) of between 4 and 5 (source: RWS). There are other costs related to environmental pollution and noise, though an analysis based on several combined sources, including European studies, suggests that where heavy queuing occurs, the combined economic cost of other environmental impacts is only around 10% of congestion cost as currently calculated (Taylor 2006a).

[9] Range of valuations in northern European countries – valuations elsewhere in Europe can be much lower.
[10] Based on the 2005 figure for fatalities and the reported percentages.
[11] Based on the average northern European fatality cost, and cost ratios from the United Kingdom.
[12] Although these figures are calculated using the higher accident costs in the table, their sum is consistent with the total of €180 billion quoted in the ETSC report.

22.5 The cost of congestion caused by a motorway incident varies depending on its severity, duration, and the level of traffic on the motorway. The critical factors in incident delay are the number of lanes closed and the duration of their closure. When an incident occurs, a traffic queue starts to form immediately as new vehicles arrive; this is known as the arrival rate. Once the front of the queue starts to move, the traffic can start to clear, resulting in a departure rate. The difference between the two rates, coupled with the initial duration, determines how quickly the queue disperses.

22.6 The UK Department of Transport (DfT 2010/2011) has estimated figures based on queuing principles. These figures, which have been converted into euros at the rate of £1 = €1.1, are reproduced in the table below. These values are considered conservative as secondary effects further increase congestion and may also contribute to congestion on diversion or alternative routes. On average, for every 30 hours of queuing there will typically be one additional secondary collision from a vehicle running into the back of another vehicle in the queue. A study of 163 incidents on the M6 motorway in England showed that 48 (29%) also resulted in clearly identifiable congestion on the opposite carriageway from 'rubbernecking'.

| Flow (% of capacity) | Lanes closed (out of 3) | Duration of incident closure | | | |
|---|---|---|---|---|---|
| | | 15 minutes | 30 minutes | 1 hour | 2 hours |
| 80% (busy) | 1 | € 517 | € 2,068 | € 8,272 | € 33,088 |
| | 2 | € 3,619 | € 14,476 | € 57,904 | € 231,616 |
| | 3 | € 9,306 | € 37,224 | € 148,896 | € 595,584 |
| 60% (moderate) | 2 | € 1,034 | € 4,136 | € 16,544 | € 66,176 |
| | 3 | € 3,490 | € 13,959 | € 55,836 | € 223,344 |
| 40% (quiet) | 2 | € 173 | € 690 | € 2,758 | € 11,030 |
| | 3 | € 1,551 | € 6,204 | € 24,816 | € 99,264 |

[In the above, the comma separator indicates thousands. There is no delay if not busy and only one lane is blocked]

Fig. 32

## Causation and the involvement of large goods vehicles (LGV)

22.7 The original cause of an incident also has an effect on the time needed to clear the blockage (Frith 1999). A study in the West Midlands of England showed that just 5% of incidents were responsible for 75% of the total incident-related delay. Multiple-vehicle incidents and those involving large goods vehicles (LGV) represent less than 10% of all incidents yet cause more than half of all incident-related congestion. The impact of LGVs on the English core network has been summarised by TRL (2006), which finds that LGVs are involved in 23% of personal injury accidents, and 27% of fatal and serious accidents despite substantial safety improvement mainly thanks to under-run guards. On average, an accident involving an LGV closes 1.3 lanes for twice as long as a non-LGV accident. Although LGVs represent about 15% of motorway vehicle-km in England, LGV accidents cause at least 26% of accident-related delays. Because of the size and weight of the vehicles, and the likelihood of overturning and shed loads, clearance is much more complex and time-consuming than in a light vehicle accident; cranes are often needed, and such accidents can involve contamination of the road with diesel fuel. Clearance times and clearance time targets in the Netherlands, as exemplified in Appendix A, are much longer than for incidents involving light vehicles.

## Reducing congestion and delay by quicker response

22.8 As pointed out in Chapter 1, traffic incidents cause congestion and associated economic costs, as well as danger to and loss of life. The longer it takes to clear an incident, the greater the resulting congestion, and the greater the consequent effects of congestion. In Fig. 33 (based on one in EasyWay 2009b), time runs from left to right, the incident occurs at O and the queue size at any time is represented by the height of the triangle. Initially, blockage is assumed total, zero departure rate being represented by the line OA or OAB. The build up of the queue is represented by the line OD or ODC, and total delay (normally measured in vehicle-hours) by the area OAD or OBC, depending on whether the incident is cleared at time A or B. One key observation is that if traffic continues to arrive at the scene at a constant rate, the total queuing delay increases as the square of time, showing the benefit of early clearance.

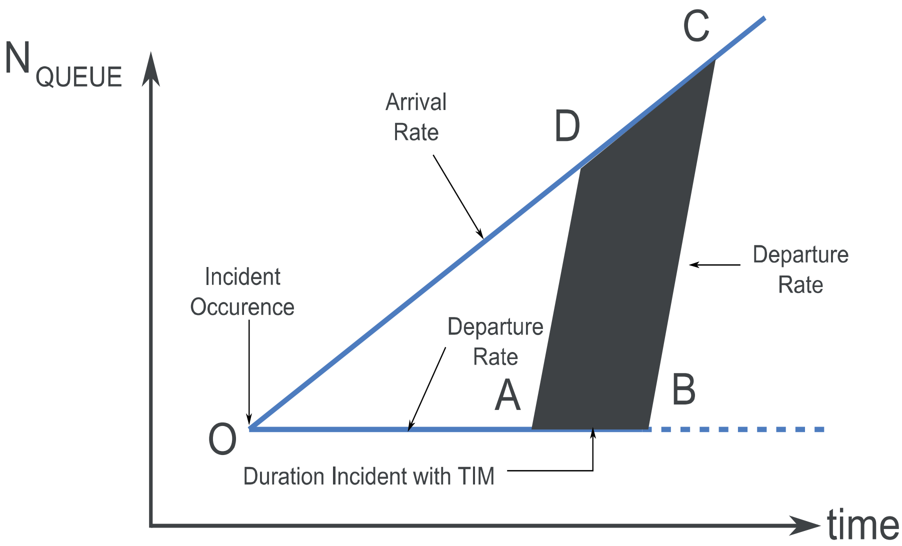



Fig. 33

## Persistence of queuing and other consequent events following a blockage

22.9 When most real queues discharge, the head of the queue extends upstream away from the blockage, rather than the tail diminishing in the direction of the blockage (see, for example, Taylor 2006b). There is the view that capacity can remain 10–15% below normal until traffic becomes free-flowing again. As long as there is a queue, there is in effect a bottleneck, and the tail of the queue continues to move upstream. Thus the risk of secondary incidents is increased beyond the duration and immediate vicinity of the incident itself, in proportion to the actual persistence of queuing.

22.10 In extreme cases of heavy demand, the front and back of the queue may not meet, resulting in a persistent jam that extends upstream at around 19 km/h until demand falls below a certain threshold. Apart from the delay such a jam causes, it creates a risk of **tertiary incidents** for an indefinite period. These effects are difficult to quantify and predict without detailed information, and even then, they remain unpredictable because of their probabilistic nature. Other effects of queuing may occur elsewhere than in the queue itself.

22.11 All these processes are illustrated by the distance-time plot in Fig. 34, generated in MTV (Motorway Traffic Viewer)[13], which shows the effect of dense traffic released from a bottleneck. In the plot, time increases from left to right, and distance from upstream to downstream, and the direction of traffic is from bottom to top. The plot is made of 500m x 1 minute cells in which average traffic speed is shown by grey scale, with black the highest (around 120 km/h) and white the slowest (10 km/h or less).

22.12 In Fig. 34, the primary queue is released at point **A**. The queue was actually caused by a slow-moving abnormal load on a section of the M6 motorway in England, upstream of point A (not shown[14]). The 'shadow' of this event can be seen extending downstream at around 90 km/h. The heavy discharge flow to its right, which considerably exceeds the average ambient flow into the original queue, travels downstream with some dispersion for over 20km before it hits another localised bottleneck at point B, causing flow breakdown and secondary queuing.

22.13 The secondary queue forms periodic moving jams, visible as oblique white streaks, one of which appears to lead to an incident at point C, producing almost stationary queuing there for an hour. This incident occurs 2½ hours after the primary queue was released and 1½ hours after it dispersed (the primary queue itself left a persistent moving jam extending many km upstream of point A, though this is not shown for the same reason as before.)

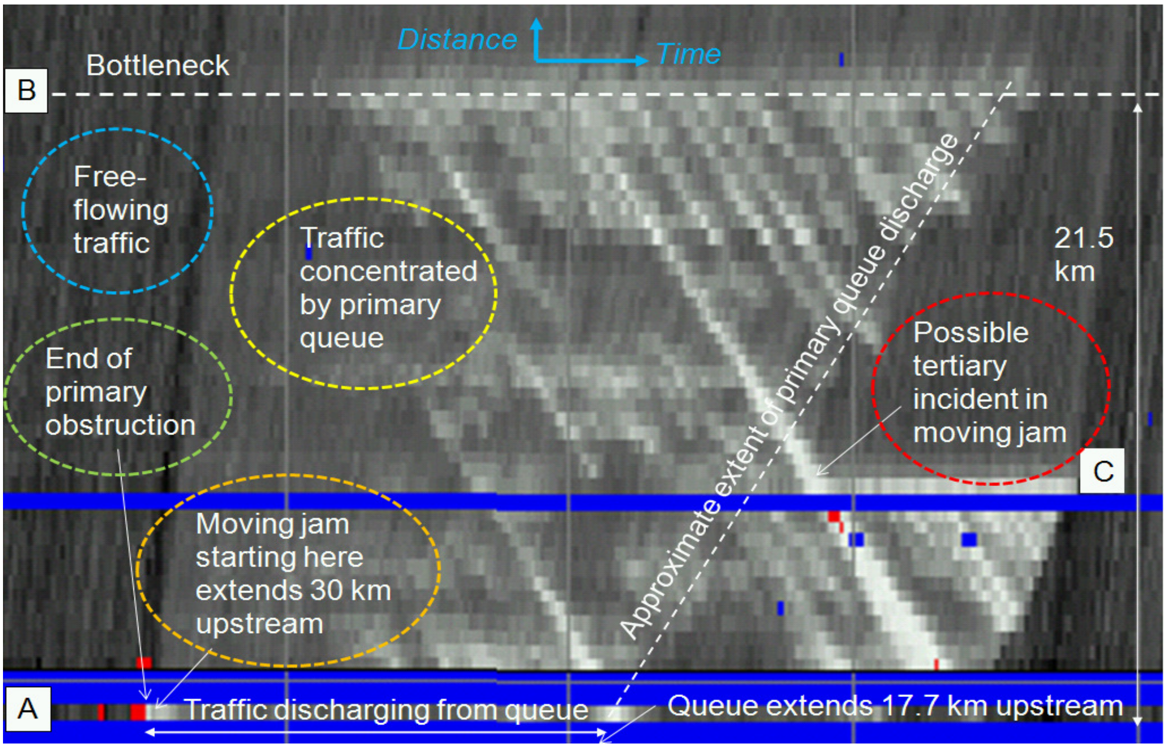



Fig. 34: Persistent jams and possible tertiary incident caused by queuing at a blockage

[13] The MTV software (likely to be renamed), which was developed by TRL in England, was probably the first graphical space-time display of detector values. An on-line version is available. Similar plots are found in many publications.

[14] The cause upstream of point A is not shown because at the time, many detectors there were not providing data.

## Reducing incident risk through prediction

22.14 Traffic as visualised in a space-time plot evidently has 'preferred directions', namely downstream at free speed, typically 100–130 km/h, and upstream at jam wave speed, typically 18–20 km/h (see for example Treiber, Kesting, and Wilson 2009). This, together with the wealth of detector data now available or becoming available, suggests the possibility of prediction, not only of future traffic states but of their possible implications for the risk of flow breakdown and incidents.

22.15 Although there is ongoing research in this area, it remains largely at the academic stage. Consequently, the potential benefits for safety and cost-saving have yet to be realised. One possible reason may be the difficulty of getting access to enough raw data to demonstrate large-scale patterns underlying the random 'noise' of traffic. Another factor is the size of the analysis task—literally of astronomical proportions—of locating and recognising critical events in a vast mass of otherwise 'uninteresting' data, which suggests that sophisticated automatic techniques will be needed. Finally there is the difficulty of drawing conclusions and estimating benefits when events are so varied in nature and unrepeatable. Despite these issues, it must surely be the case that skills and techniques which exist for handling vast amounts of data and modelling complex systems—such as those used in image processing, astronomy, and weather forecasting—could potentially be applied to traffic prediction.

# 23 Incident prevention measures

23.1 Incident prevention measures identified in the CEDR TIM survey are shown below. The relative down-ranking of measures in the 'planned' column need not imply that they are considered likely to become less useful in the future, but may only indicate that they are already fully deployed. However, it is significant that a more systematic collection of statistics, ITS, driver education, and more locally targeted treatments rank highly among the planned measures.

23.2 Current and planned use of measures in primary incident prevention

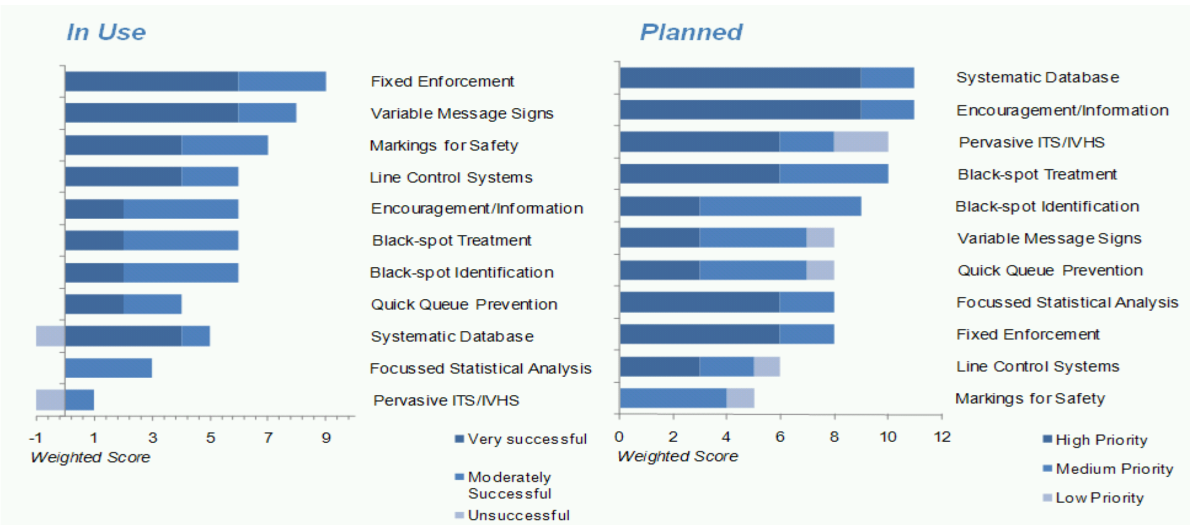



Fig. 35: Current and planned use of measures in primary incident prevention

23.3 Current and planned use of measures in prevention of secondary incidents

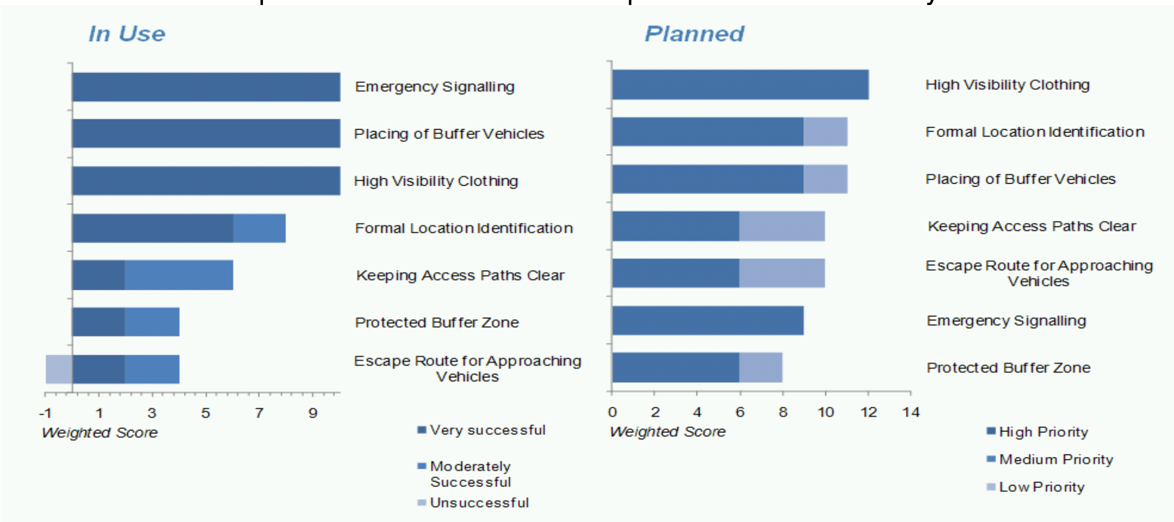



Fig. 36: Current and planned use of measures in prevention of secondary incidents

## 24 Governance, strategy, assurance, and other factors

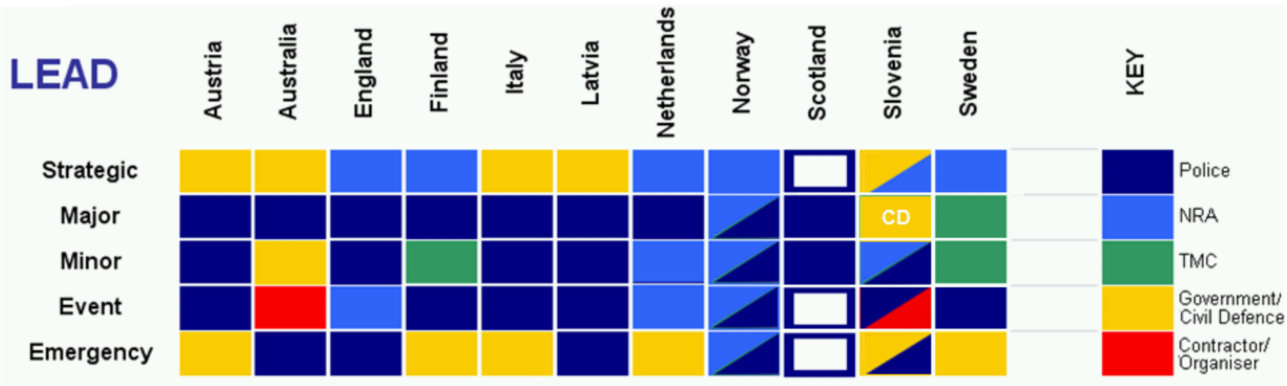
Incident management takes place within the context of political, institutional, social, and geographical conditions in each country and within an overall framework of business best practice. These factors influence how management is conducted, how responsibilities are divided, and the areas on which effort is focused, and need to be understood before paths of development can be mapped out.

24.1 TIM governance can be viewed as a cycle of four high-level activities (see Fig. 37):


Fig. 37

## Roles and responsibilities

24.2 Responsibilities are likely to be defined externally: explicitly by government, or implicitly taking account of the established roles of other responders, especially the police. As shown in Fig. 38, which is based on the CEDR TIM survey and subsequent adjustments[15,16], the police are more involved in leading incident management than any other responder across Europe.




***Note that the police are likely always to retain the option to take the lead***

Fig. 38

24.3 Roles and responsibilities in TIM will reflect the remit and resources of the NRA, which are not determined solely by the NRA and are therefore dependent on governmental **policy**. They will also depend on the degree of TIM **coverage**, i.e. the extent of the road network where TIM is deployed.

24.4 Within these constraints, the NRA will develop its overall **strategy** for incident management. This defines its overall objectives and the on-line and off-line components required to achieve them. **Plans** in this context relate to on-line activities and could include development and deployment projects as well as response plans to meet as many as possible of the TIM objectives.

24.5 Finally, the NRA will **review and test** its plans to determine their effectiveness in enabling the NRA to fulfil its role and meet its responsibilities.

## Assurance

24.6 This concept is more pro-active than quality assurance, which means having mechanisms for systematic monitoring and evaluation within processes. It includes a degree of circumspection or not taking things for granted, as well as ensuring compliance with organisational and operational policy, guidance, and procedures. For example:

- If past data is used to make policies, was the data really valid, is the data still valid?

[15] An earlier version appeared in the interim report. Outlined cells are inferred as no information was provided.

[16] In this context, 'government' can be both national and regional. In Slovenia, Civil Defence, under the Ministry of Defence, is responsible for 112 emergency calls and also for activating the fire department and ambulance.

- Could established practices or culture be masking poor performance in any area?
- Systems seem to work, but is there hidden potential that is not being exploited?
- How reliable is the data that has been collected?
- How trustworthy is the reporting chain?

  - Multiple responders create complexity
  - Potential for confusion during incidents
  - Statistics collected after an event are subject to memory-fade
  - Is there reporting bias in the statistics?
  - Are anomalies pursued or ignored?

- If targeting of interventions is based on high-level evaluation metrics:

  - Aggregated data are susceptible to bias
  - Is the cost of monitoring/evaluation factored into delivery cost of new systems?

### Focusing on congestion

24.7 Congestion is a major cost to economies, but congestion reduction is not universally recognised as a goal of incident management. Of the 19 countries involved in the CEDR TIM survey, six stated that they view incident management as a way of reducing congestion, though two stated that they do not where non-injury incidents are concerned. Across Europe, incidents account for 10–25% of congestion. Non-injury accidents are also estimated to cause much congestion, for example 30% in the Netherlands. In the USA, where average traffic levels may be somewhat lower than in Europe, one source estimates that 60% of congestion arises from incidents, so incident-related congestion may be a more significant proportion of the total in countries with less densely trafficked networks.

24.8 The graphic[17] below shows which responders in a number of countries are most responsible for managing congestion. Although the police are shown to play a large role in minimising congestion, their primary duty and motivation is to ensure safety and law enforcement.

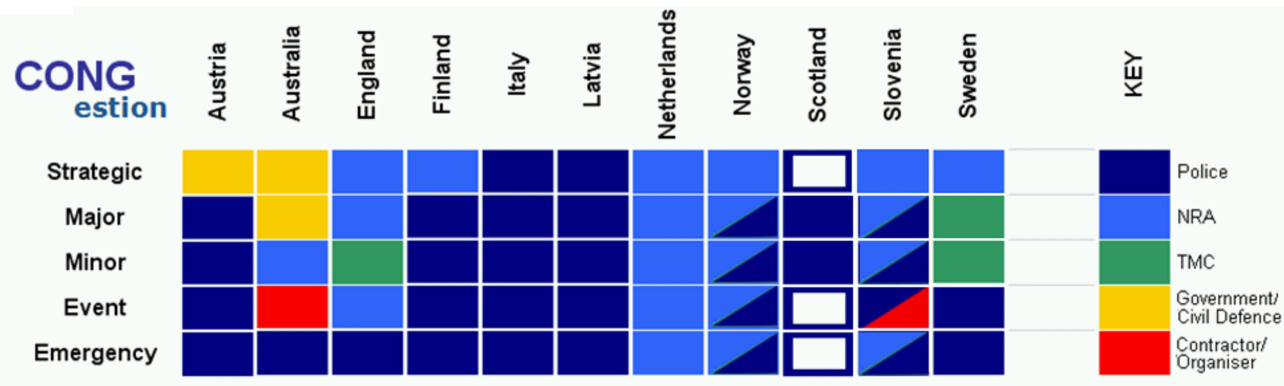



Fig. 39

[17] The LEAD and CONGestion Graphics are based on the data provided or available at the time of writing.

24.9 In those cases where an NRA gives high priority to reducing congestion or takes on more roles from the police by employing traffic officers, in order to maintain safety, the NRA must develop strategies and multi-responder cooperation plans, and be capable of proactive measures rather than just react to situations, thereby moving more towards the role of the network manager.

### Factors impacting on incident management

24.10 Various external factors can influence the need for—or the perception of the need for—and the practicalities of incident management, for example:

- **Criticality of the overall network:** in those cases where alternative modes such as rail are scarce or non-existent, or where alternative roads are few or unsuitable (e.g. in mountainous regions), the social and strategic importance of keeping roads open increases.

- **Critical points in the network:** some countries' networks may include critical tunnels and bridges or bottlenecks arising from geographical and demographic conditions, where maintaining safe and efficient operation justifies specific incident management measures.

- **Weather:** in those cases where severe weather (in particular snow, flooding, and landslides) can disrupt service and increase emergency access times, special preparedness and planning may be justified.

- **Crime:** some parts of a network may be used by criminals more than others, for example near large cities, and an increased likelihood of police activity, joyriding, car chases, people driving the wrong way etc., may need to be taken into consideration.

- **Economic reality:** even the best ideas for improving incident management have to compete for funding with other projects inside and outside the national transport budget allocation. Balanced mixes of cost-effective solutions may prove more realistic.

- **Limitations on infrastructure:** existing network infrastructure and technology will limit the development of incident management in areas that are reliant upon such infrastructure. Forward planning and open system design can help reduce these issues.

# APPENDIX C

## Developing capability as a traffic incident manager

For definitions and references see Appendix D

## 25 TIM in the wider context of Europe and the ITS Action Plan and Directive

There are common aims and objectives within Europe, but it is impractical to be prescriptive about how TIM should be practised or developed in different countries or to lock NRAs into procedures and technology that may become obsolete. This document aims to provide a framework within which NRAs can achieve both national and common objectives.

Many of the objectives of the ITS Action Plan and EasyWay are directly compatible with those of CEDR. Nevertheless, it is the NRAs, as represented by CEDR, who will implement the policies or recommendations arising from directives, the ITS Action Plan, EasyWay, or CEDR's own research, so it is essential that such outputs reflect the level of service that each NRA is content with and that is practically achievable at present or as a future objective.

25.1 **The EC's ITS Directive 2008/0263,** which has been adopted by the European Parliament, does not specifically mention incidents or accidents, but gives priority to harmonised eCall and free safety-related information services and generally favours the use of mobile electronics. The aims of the EC's ITS Action Plan, working through EasyWay (Herrenda 2010) and other projects, are to:

1. implement the road traffic safety standards (ISO/WD 39001)
2. reduce congestion, increase safety and efficiency
3. recognise that the ITS industry has strategic importance in its own right
4. increase the pace of deployment of ITS in road transport
5. promote seamless real-time travel and traffic information, including multi-modal travel and traffic information
6. promote freight information to optimise efficiency and minimise environmental impact
7. deploy the eCall automatic emergency alert system
8. promote electronic toll collection.

25.2 The impact on incident management is therefore indirect. Conversely, however, incident management could help to achieve some of these aims. Although eCall appears directly relevant, interest among NRAs is mixed, particularly where they already have effective incident detection systems in place.

25.3 General areas where incident management could benefit from harmonisation are:

- location marking and coding
- road signing and marking conventions
- variable message sign pictograms and conventions (ESG4 MareNostrum)
- emergency calling procedures for road users (eCall etc.)
- the general understanding of legal responsibilities of road users
- safety standards for critical sites such as tunnels.

25.4 Most of these relate to road users, who are the main ones crossing borders. Provided that responders' cross-border cooperative arrangements work and are compatible with other players, there appears to be no pressing need to harmonise the details of TIM practice. One exception is safety standards at critical sites, where operators need to be able to reliably manage and communicate with road users—and possibly with neighbouring operators—from other countries. European Directive 2005/54/EC already sets minimum safety requirements for tunnels.

## Coordination between CEDR and EasyWay

25.5 Formal coordination between CEDR and EasyWay exists at governance level through CEDR's Thematic Domain Operation (TDO), and at technical level through task group 14, which will continue until March 2013. Following the approval of EasyWay Phase 2, this is now being actively pursued. EasyWay embraces a large number of organisations and interests, is conducting 7 regional projects, and has issued 19 Guidelines to date. It is involved in incident management through its European Study Group 2's (ESG2) Guideline for Deployment of Incident Management (EasyWay 2009b), to which reference has been made several times in this report. EasyWay's goals include:

1. a common harmonised policy at European level
2. ITS and TIS deployment on main TERN corridors
3. the embracing of the ITS Action Plan and stakeholder concerns
4. concentration on deployment, avoiding fragmented technical solutions
5. a reduction in $CO_2$ emissions
6. a reduction in congestion
7. coping with an anticipated 36% increase in road travel by 2020
8. coping with an anticipated 55% increase in road freight by 2020
9. a reversal of any growth in fatalities.

## Interaction of the driving influences

25.6 One concern is that standards and directives should be flexible enough to allow for technical and policy development. Incident management is unique within traffic management because of the wide range of possible levels of service and the degree to which it relies on coordinating a number of different and semi-independent organisations.

25.7 The purpose of Fig. 40 is to summarise the relationships between the various sources and players influencing the provision and development of incident management and potentially other NRA functions. One significant feature is the feedback paths to complete 'learning loops'.

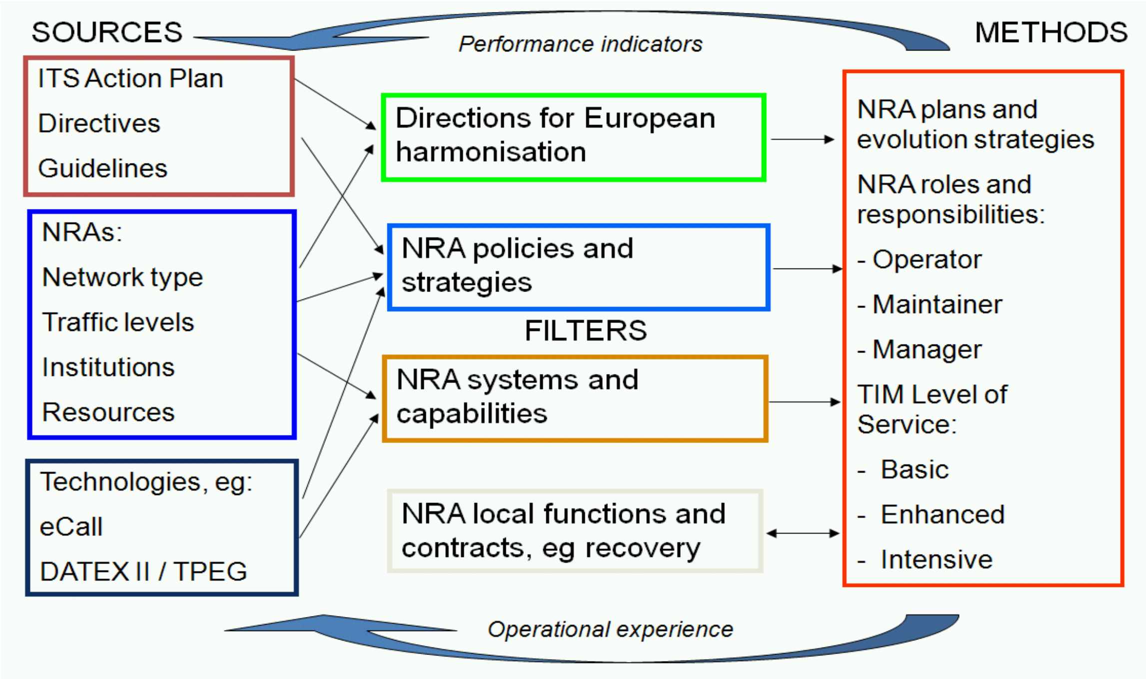



Fig. 40

## 26 Developing capability as an incident manager

Fig. 41, which also appears in the main report, combines NRAs' **responsibility** (as network maintainer, operator, or manager), **coverage or penetration** (i.e. where and when TIM is implemented) and **level of service** (which in practice means the structures and organisations through which TIM is implemented), and the specific **capabilities** they represent.

These depend on the NRA's remit and can vary according to need and resources. Fig. 41 also expresses the possibility of development along each of the dimensions. This will usually be a step-by-step process, and not only technical but also institutional. Some steps can be small, but others may be larger and may involve significant investment and risk.

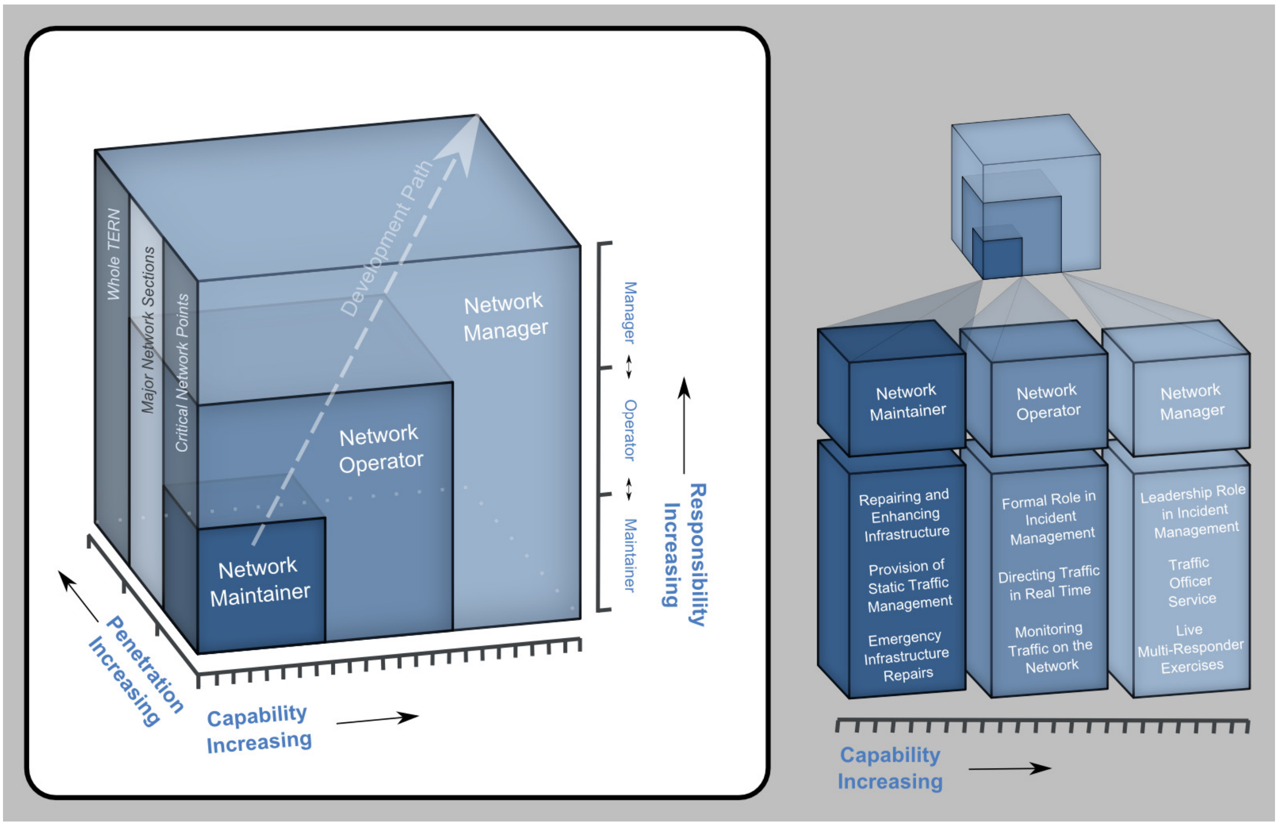



Fig. 41: The 'TIM Space'

## Steps in building capability

26.1 An NRA stands to benefit considerably from improved incident management as it becomes an excellent network operator or manager. Reducing the frequency, severity, and clearance times of incidents will support the delivery of journey reliability and safety targets, demonstrate good value for money, and deliver good customer service.

26.2 The process of building capability towards becoming an incident manager can be visualised as the following 'road map' developed by the English Highways Agency (CEDR 2009):

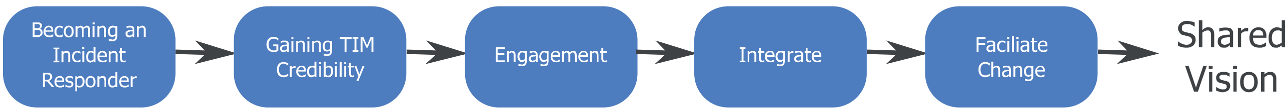



Fig. 42

## Becoming an incident responder

26.3 Before embarking on this path, an NRA should already both play a role—either directly or through its service providers—supporting incident commanders and have the capability to provide trusted, reliable, and valued information to road users. A traffic control capability would also be an obvious advantage. An NRA may see a role for a traffic officer service that can take over roles and responsibilities from the police. To become an incident responder, the NRA must integrate these services to deliver efficiently and present clear roles and responsibilities to other responder organisations.

## Gaining TIM credibility

26.4 The credibility of the NRA with other responders in traffic incident management is key to delivering longer-term change in incident management. Credibility can only be achieved over time and in its relationships at all levels. However, important features of a credible incident responder include: collaboration and cooperation with other responders, delivering a learning environment, and sharing information and intelligence. Credibility has to be earned and maintained and is vital to progressing to the next stages.

## Engaging, integrating, and facilitating change

26.5 Full and longer-term benefits can only be achieved by working with other responders. This is indicated on the development path as 'engagement', 'integration', and 'facilitating change'. An NRA can begin by implementing these stages at operational level. However, further development will require these foundations to be built on in order to further develop and sustain strategic partnerships with other key responding organisations. It may be that the most effective means of delivering these stages will be to focus attention on a single organisation, such as the police, and complete the stage before considering relationships with other responders.

26.6 The three stages may be summarised as follows:

- During the **engagement** stage, seek to agree a shared vision for incident management together with strategic agreements and establish multi-agency governance arrangements for its delivery.
- During the **integration** stage, build upon this to clarify the roles, responsibilities, accountabilities, and liabilities of responders. One important output is agreed operational guidance for all responders.
- During the final **facilitating change** stage, seek and negotiate improvement to the management of incidents between responders and deliver changes to procedures that will benefit all parties.

## On-going initiatives

26.7 The development stages can be supported by a number of on-going initiatives with both an internal and an external focus, e.g. liaison with stakeholders or the development of communications systems.

## Wider benefits

26.7 Wider benefits of incident management include a reduction in pollution resulting from incidents and the congestion they cause. If the TIM strategy is to be delivered, there must also be significant benefits for other responding organisations such as the improved delivery of their objectives and more efficient use of resources. These benefits should be identified and quantified at each stage of the development path.

### Overcoming constraints and incompatibilities

26.8 There will inevitably be constraints on how quickly an NRA can achieve its strategy. In the short term, it will need to concentrate on embedding its core functions to deliver immediate targets. It may encounter internal organisational barriers, but the effort should help to break them down. There will also be external barriers, in particular the conflicting priorities and objectives of other responders. For instance, an NRA may be driven by a commitment to reduce incident-related congestion, whereas the priorities of the police will be their law enforcement duties and the requirement to investigate incidents to establish cause and responsibility. It is therefore vital that in those cases where priorities are incompatible, compelling benefits are identified for all the organisations involved. Otherwise, compromise and change will be impossible.

## 27 Setting up supporting organisations and systems

Various organisations may be set up or employed by NRAs to perform specific functions. Their typical constitutions and terms of reference are described here.

### Traffic officer service (TOS) (England) / Weginspecteur/Officier van dienst (Netherlands)

27.1 A specially organised and trained service of traffic officers will be most relevant in countries where there is heavy traffic on large parts of the strategic road network. Traffic officer services were established in both the Netherlands and England in 2004 (HATO 2004, VKRC 2010). Italy also has some traffic officers. Typical features are:

- Within their areas of operation, traffic officers (TOs) take over non-crime-related tasks from the police, although the police may keep overall command.
- There should be traffic management centres to assist in the dispatch and deployment of TOs; these may be staffed by TOs.
- TOs should have legal powers to stop and direct traffic. In England and the Netherlands, while TOs do not have legal powers of arrest, it is an offence not to comply with their directions and advice.
- TOs should have the authority, either directly or via their TMCs, to call in recovery teams and other necessary resources.
- There should be a formal Guidance Framework for TO responsibilities and operations.
- The public should be informed about the role and powers of TOs.


### Incident support units (ISU)

27.2 Although they may be known by other names, incident support units are essentially staff or contractors provided by the network operator or a service provider, with specialised vehicles and equipment, whose task it is to assist the police or traffic officers, provide a safe and timely response to incidents, and clear the carriageway to restore normal service. The primary functions of ISUs may also include:

- assessing the incident scene and calling in additional or specialist resources where the task is beyond the ISU's capabilities;
- acting as a communications link between the incident scene and a control centre;
- making the incident scene safer through the application of appropriate traffic management;
- removing hazards, clearing debris from traffic lanes and hard shoulders, and performing immediate repairs to damaged highway infrastructure.

## Vehicle recovery operators (VRO)

27.3 VROs are likely to be private companies whose main business is the recovery and removal of crashed or disabled vehicles to a police pound or repair garage or other holding area for insurance assessment. If under contract, they may be subject to a maximum response time. On English motorways, for example, in cases where a light vehicle is obstructing the road, the maximum response time is 30 minutes, even if the vehicle owner calls their own recovery company. It is possible that several different VROs may be on call at different times of the day. This will depend on the local situation and conditions. For LGVs there may be specialist recovery organisations. For example in the Netherlands, STIMVA acts as a coordinator and dispatch centre for LGV recovery and salvage consultants.

## Traffic management or control centres (TMC/TCC)

27.4 A network manager is likely to require one or more TMCs to monitor its network and set signals and signs, or set in motion automatic sign-setting programmes, for example dynamic use of the hard shoulder. Where a TMC is operated 24 hours a day, 7 days a week, with shifts, it may require up to three times as many staff as are occupied with traffic management at any one time. In busy networks, because of the very visible effect of congestion, incidents, and weather events on a busy network, TMCs can develop a high political profile. It therefore needs to be understood that the TMC needs investment to enable it to perform the job as it is publicly perceived. A TMC is the hub of a **traffic management system** consisting of the road network, the communication and control infrastructure (gantries, signs, detectors, cabling etc.), staff both at the centre and on the road, and responders and mobile equipment. Clear responsibilities and powers and coordination between responders are, therefore, particularly important and are supported by formal agreements and logging systems. A TMC can have a dedicated link to the media for channelling information to drivers. An example is at Verkehrszentrale Hessen (pictured below), where a permanent desk is provided in the control room for a member of the local radio station.

## National versus regional control centres

27.5 In England, traffic management is handled by seven regional control centres (RCC), which are responsible for positive traffic control and incident management. The single National Traffic Control Centre (NTCC) is defining its more strategic role of providing up-to-date information to the public and the media and providing strategic diversion routes, all of which may involve crossing regional boundaries.


Fig. 43: Verkehrszentrale Hessen in Frankfurt (seen from media station) (D)

Fig. 44: TMC Utrecht (NL)


Fig. 45: TMC Wolfheze (NL)

## Communication

27.6 The English Highways Agency's National Traffic Control Centre (to be upgraded to National Traffic Information Service) relies on a network of digital communications, data gathering hardware, and information dissemination systems and channels as shown in the diagrams overleaf.

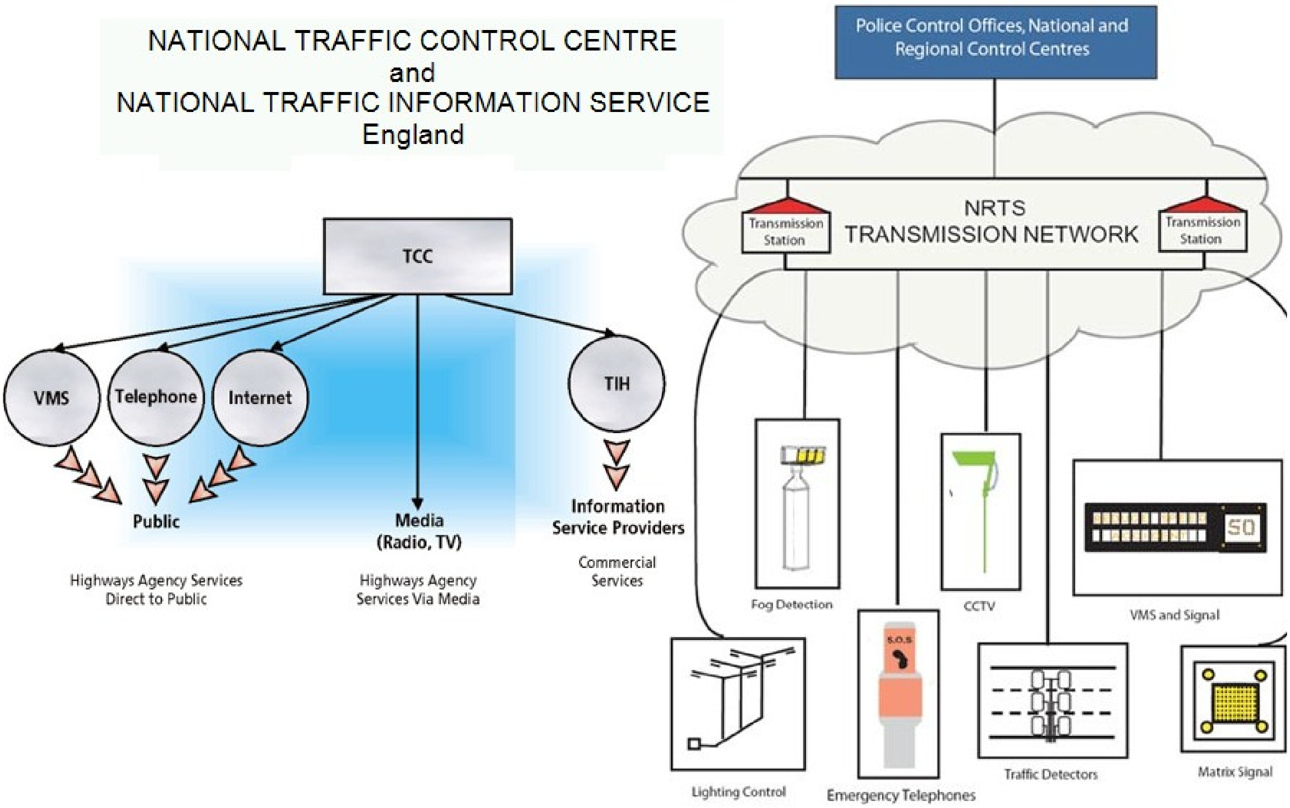
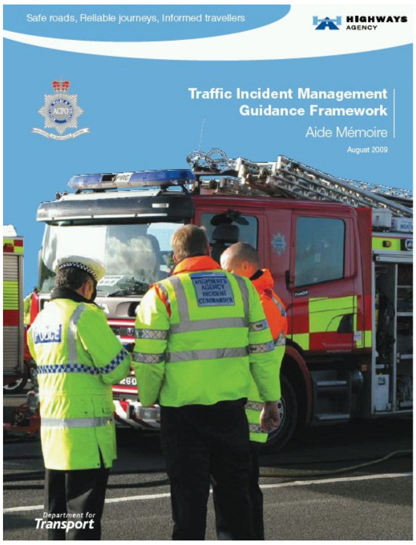
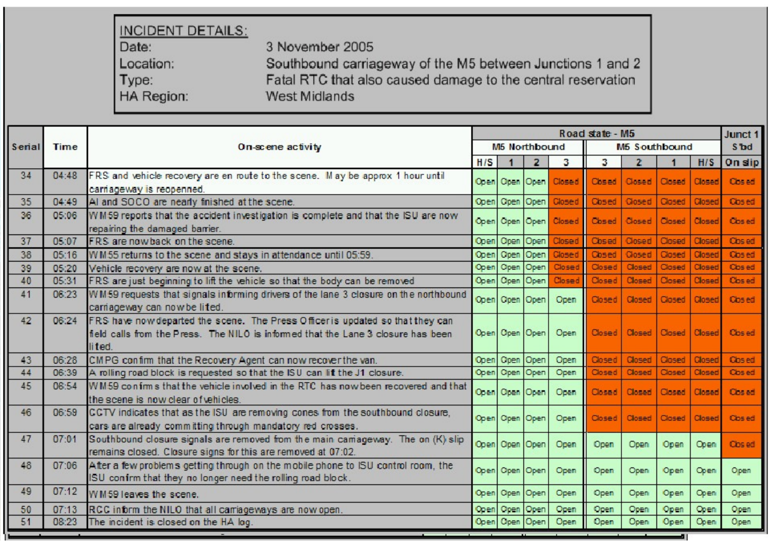



Fig. 46

## Documentation

27.7 Documentation contributes to the effectiveness and efficiency of TIM by regularising procedures, formalising the roles of and relationships between responders, and ensuring that records are kept from which experience can be gleaned.



INCIDENT DETAILS:
Date: 3 November 2005
Location: Southbound carriageway of the M5 between Junctions 1 and 2
Type: Fatal RTC that also caused damage to the central reservation
HA Region: West Midlands

| Serial | Time | On-scene activity | Road state - M5: M5 Northbound H/S | 1 | 2 | 3 | M5 Southbound 3 | 2 | 1 | H/S | Junct 1 S'bd On slip |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 34 | 04:48 | FRS and vehicle recovery are en route to the scene. May be approx 1 hour until carriageway is reopenned. | Open | Open | Open | Closed | Closed | Closed | Closed | Closed | Closed |
| 35 | 04:49 | AI and SOCO are nearly finished at the scene. | Open | Open | Open | Closed | Closed | Closed | Closed | Closed | Closed |
| 36 | 05:06 | WM59 reports that the accident investigation is complete and that the ISU are now repairing the damaged barrier. | Open | Open | Open | Closed | Closed | Closed | Closed | Closed | Closed |
| 37 | 05:07 | FRS are now back on the scene. | Open | Open | Open | Closed | Closed | Closed | Closed | Closed | Closed |
| 38 | 05:16 | WM55 returns to the scene and stays in attendance until 05:59. | Open | Open | Open | Closed | Closed | Closed | Closed | Closed | Closed |
| 39 | 05:20 | Vehicle recovery are now at the scene. | Open | Open | Open | Closed | Closed | Closed | Closed | Closed | Closed |
| 40 | 05:31 | FRS are just beginning to lift the vehicle so that the body can be removed | Open | Open | Open | Closed | Closed | Closed | Closed | Closed | Closed |
| 41 | 06:23 | WM59 requests that signals informing drivers of the lane 3 closure on the northbound carriageway can now be lifted. | Open | Open | Open | Open | Closed | Closed | Closed | Closed | Closed |
| 42 | 06:24 | FRS have now departed the scene. The Press Officer is updated so that they can field calls from the Press. The NILO is informed that the Lane 3 closure has been lifted. | Open | Open | Open | Open | Closed | Closed | Closed | Closed | Closed |
| 43 | 06:28 | CMPG confirm that the Recovery Agent can now recover the van. | Open | Open | Open | Open | Closed | Closed | Closed | Closed | Closed |
| 44 | 06:39 | A rolling road block is requested so that the ISU can lift the J1 closure. | Open | Open | Open | Open | Closed | Closed | Closed | Closed | Closed |
| 45 | 06:54 | WM59 confirms that the vehicle involved in the RTC has now been recovered and that the scene is now clear of vehicles. | Open | Open | Open | Open | Closed | Closed | Closed | Closed | Closed |
| 46 | 06:59 | CCTV indicates that as the ISU are removing cones from the southbound closure, cars are already committing through mandatory red crosses. | Open | Open | Open | Open | Closed | Closed | Closed | Closed | Closed |
| 47 | 07:01 | Southbound closure signals are removed from the main carriageway. The on (K) slip remains closed. Closure signs for this are removed at 07:02. | Open | Open | Open | Open | Open | Open | Open | Open | Closed |
| 48 | 07:06 | After a few problems getting through on the mobile phone to ISU control room, the ISU confirm that they no longer need the rolling road block. | Open | Open | Open | Open | Open | Open | Open | Open | Open |
| 49 | 07:12 | WM59 leaves the scene. | Open | Open | Open | Open | Open | Open | Open | Open | Open |
| 50 | 07:13 | RCC inform the NILO that all carriageways are now open. | Open | Open | Open | Open | Open | Open | Open | Open | Open |
| 51 | 08:23 | The incident is closed on the HA log. | Open | Open | Open | Open | Open | Open | Open | Open | Open |

Fig. 47: Guidance framework and example of incident log from English Highways Agency

# APPENDIX D

## Definitions and references

# 28 Definitions

| Term | Definition in the context of traffic incident management |
|---|---|
| access | A means by which a responder can reach an incident scene |
| aide-mémoire | A handy portable document drawn up to give trained personnel quick access to essential procedures or information |
| capacity | The maximum number of units (PCUs, vehicles, pedestrians, or other) able to pass a cross-section of the road infrastructure per time unit, usually an hour |
| CEDR (Conference of European Directors of Roads) | CEDR is a forum for the discussion and promotion of improvements to the road system and its infrastructure. Its members represent their respective national road authorities or equivalent bodies. |
| clearance | Removal of debris or vehicles usually causing a blockage to traffic |
| clearance time | The time from the start of scene management to clearance of the incident, but not including initial response time or restoration to normality |
| congestion | A condition where traffic itself becomes the primary contributor of delay, measurable by the marginal extra delay imposed by each added vehicle |
| cooperative systems | Electronic traffic management and information systems, which rely on distributed intelligence and communication between modules installed in vehicles and at the roadside |
| CVIS (Cooperative Infrastructure–Vehicle Systems) | Programme to develop cooperative systems in Europe |
| DATEX II | A European standard for digital information exchange between road traffic management centres |
| debriefing | A formal meeting of responders where each is invited to give a report on the management of an incident and any problems or issues arising |
| discovery | Initial identification by any means of a potential incident by a responsible organisation or its staff |
| EasyWay | A project initiated by the European Commission to promote the deployment of harmonised ITS and TIS on TERN |
| eCall | Automatic generation of emergency phone call to PSAPs by dialling 112 or via an intermediate service provider |
| element | A procedure, provision, or system involved in TIM. A 'horizontal' division of the TIM process and its supporting systems |
| emergency services | In particular fire-fighting services and ambulances, but also any other specialist services dealing with hazard or injury; it can also include the police |
| exercise | A live or desktop simulation of an incident where responders meet and cooperate to work through an incident scenario to test methods and performance |
| Fresnel lens | A thin lens made of successive layers that enables a wide angle view of its surroundings |
| GSM | Cellular digital UHF radio standard used by mobile telephones |
| incident | Any unplanned event, other than a vehicle breakdown on the hard shoulder, that may adversely affect the capacity of a road and hinder traffic flow, including accidents, spilled loads, and stranded vehicles |
| incident clearance (US) | The time between awareness of an incident and removal of all evidence and debris |
| incident protection or fend-off vehicle (IPV) | A vehicle suitably equipped with signs or markings to warn and physically fend off vehicles approaching an incident scene, thereby protecting responders and other persons involved and avoiding secondary incidents |
| incident duration | Total time occupied by the incident from occurrence to clearance, but not including restoration to normality |

| | |
|---|---|
| incident management (IM or TIM) | A set of procedures intended to ensure the safety of road users and responders following an incident and to enable the road to be cleared and restored to normality as quickly and safely as possible |
| incident screen (or calamity screen) | A temporary screen erected in the event of an incident to reduce its effect on passing traffic in either direction resulting from either increased driver caution or 'rubbernecking' |
| indicator | A defined measurement of the state of the network or the performance of a particular system or intervention |
| initial response | The dispatch of appropriate resources to the incident scene, the deployment of information, signing, and control measures to stabilise the scene and prevent escalation, and the securing of the scene for safety and so that immediate attention can be paid to casualties and hazards |
| intelligence | The processing of data to extract information and meaning on which understanding or decisions can be based |
| intervention | Any defined physical or control measure to control, manage, or assist traffic or improve system performance |
| ITS (Intelligent transportation systems and services) | A broad category of systems that use machine intelligence to inform, control, or assist transportation |
| ITS Action Plan | An initiative by the European Commission to reduce congestion and increase safety and efficiency through the deployment of ITS in as seamless a manner as possible across national boundaries |
| IVHS (Intelligent Vehicle Highway Systems) | Programme to develop Cooperative Systems in the USA |
| laser scanner | A laser system that scans a scene to create a 3D colour representation from its viewpoint. By combining several scans from different positions, a detailed model of the scene can be created enabling investigation after the scene has been cleared |
| lead | Responder with regulatory, agreed, or de facto responsibility to lead, call in, or manage other responders. |
| level of service | An ordered measure of the extent and quality of service provided by traffic management and TIM |
| LGV | Large Goods Vehicle (EU term) = HGV (Heavy Goods Vehicle) in the UK |
| location | A formal method for coding position such as road number and kilometrage or GNSS code |
| major emergency | A one-off critical event whose effects—direct or indirect—are more than local and which could require not just remedial measures but positive action to keep the situation under control |
| mandatory | Required by law or regulation; not advisory |
| national road authority (NRA) | The highest authority with practical responsibility for the major road network including TERN routes |
| normality | The traffic conditions expected at a location on a particular day and at a particular time of day |
| PCU/PAE | 'Passenger Car Unit' (Netherlands: PAE), a measure of the capacity used up by a vehicle compared to an average private car, which counts as 1 PCU. This may depend on many factors, but typical values are 2.5 for buses, 1.9–2.0 for LGVs, and 0.5 for cyclists |
| penetration | The fraction of road users or other clients equipped with or reachable by an information or management system |
| pervasive | A system where computation and intelligence is thoroughly integrated into common objects and activities |
| phase | In the context of TIM, one of the stages of the TIM timeline. A 'vertical' division of the TIM process |
| primary incident | An incident which occurs in conditions that would be considered normal |
| protection | An arrangement—e.g. of signs, cones, barriers, or positioned vehicles—that is intended to prevent or reduce the risk of further accident or injury |

| | |
|---|---|
| PSAP (public safety answering point) | A call centre where emergency calls are received and response actions initiated |
| recovery | The recovery of vehicles, loads, obstacles, and debris from the carriageway and the carrying out of essential repairs to the infrastructure before restoring the normal traffic condition |
| responder | An organisation or staff whose role is to take some action related to an incident including attending the scene. |
| response time | The time that elapses between receiving a call for attendance at an incident and being ready at the scene |
| restoration to normality | Restoration of the traffic conditions to those expected at the location for that particular day and time of day |
| restoration time or normalisation time | The time needed to restore traffic conditions to those expected at the location for that particular day and time of day after clearance of the incident |
| roadway clearance | The time between awareness of an incident and restoration of lanes to full operational status (US) |
| rubbernecking | When drivers are distracted by the incident scene or may just feel inclined to proceed more cautiously, causing additional delays and secondary incidents |
| scene management | Management of activities that need to be completed at the scene before the incident location can be cleared, including protection of the scene, implementation of diversions or other traffic management measures, relief of trapped traffic, further treatment and evacuation of casualties, removal of hazardous chemicals, investigation of the incident, and collection of evidence |
| secondary incident | An incident resulting at least partly from the unusual conditions (e.g. queuing) directly related to the primary incident |
| special event | A planned exhibition, concert, football match, or similar public event that could impact on traffic |
| TCC or TMC | A traffic control centre or traffic management centre. An office with direct monitoring and control of all or part of the road network. |
| TERN | Trans-European Road Network, consisting of designated roads |
| tertiary incident | An incident caused by but remote from the primary incident |
| TETRA | TErrestrial Trunked RAdio comprises a suite of open digital radio standards for mobile radio users, including an interoperability standard which allows equipment from multiple vendors to inter-operate with each other. Uses pulsed signals of lower frequency and longer range than GSM (< 1GHz) |
| TIM | traffic incident management |
| timeline | The phases of a traffic incident and the response to it |
| TIS (traveller information systems) | Centrally coordinated and user-friendly travel information for road and in some contexts other transport users |
| total vehicle delay | Total additional travel time incurred as the result of an incident, usually measured in vehicle-hours |
| TPEG | A 'bearer-independent', language-independent and end-user-focused standard for coding and conveying transport information, suitable for digital transmission and reproduction |
| traffic jam | A condition where traffic is brought to a standstill or crawl speed either continuously or intermittently. 'Jam' often implies that the traffic state is close to 'jam density' where movement is virtually impossible[18]. |

[18] Different countries may have various more detailed definitions of traffic states according to average speed etc. However, the average speed in a queue results from a balance between the available throughput capacity and the normal capacity of the road being obstructed (usually dependent on the number and width of lanes). The situation where some traffic is forced to halt intermittently arises where jam waves extend upstream (referred to incorrectly as 'shock wave' and in Germany as 'wide moving jam'). This is a specific phenomenon consequent on the dynamical interaction of vehicles in a queue.

| | |
|---|---|
| traffic officer (service) (TOS) | Specially trained NRA staff with defined powers to direct traffic and with a close relationship with traffic management centres in monitoring and patrolling the strategic network. |
| UHF Radio | Non-digital radio using ultra high frequency range 300–3000 MHz |
| validation | Ensuring that information is true and accurate |
| vehicle recovery operator (VRO) | Usually a private company contracted to remove and, if appropriate, dispose of vehicles from an incident scene |
| verification | Clarification and confirmation of the location, extent, and key details of an incident as far as is possible, enabling appropriate resources to be deployed |
| weigh-in-motion (WIM) | Device for measuring the axle weight of a passing vehicle |

## 29 References

Brubaker P (2010). Now and then. ITS International, July/August 2010.

CEDR (2009). Traffic Incident Management. *Final Report of CEDR Task 5*. May 2009. Published on CEDR's web site http://www.cedr.eu **(*traduction française disponible*)**

CEDR (2010a). *Comparison of Congestion Policies of National Road Authorities.* Final Report of CEDR Task 11, February 2010. May be available on CEDR's web site http://www.cedr.eu

CEDR (2010b). *Interim Report of CEDR Task 13* (including Survey Analysis), May 2010. May be available on CEDR's web site http://www.cedr.eu

CEDR (2013). *Final Report of CEDR Task 12* (including TM Factsheets). May be available on CEDR's web site http://www.cedr.eu

Chou C, Miller-Hooks E and Promisel I (2010). Benefit-cost analysis of freeway service patrol programs: methodology and case study. *Advances in Transportation Studies Journal Section B20*.

DfT (2010/2011). Guidance on valuation of travel time in the UK. http://www.dft.gov.uk/webtag/documents/expert/pdf/unit3.5.6.php

EasyWay (2009a). *Guideline for the deployment of access to abnormal and dangerous goods transports.* EasyWay Core European ITS Services and Actions. v1.0, 30 October 2009.

EasyWay (2009b). *TMS-DG08. Guideline for the deployment of Incident Management. v0.5*, 15 Dec 2009.

eCall (2009). Saving lives through in-vehicle communications technology. European Commission Factsheet. http://ec.europa.eu/information_society/doc/factsheets/049_eCall_august09_en.pdf

ETSC (2006*). Road deaths in Europe.* European Transport Safety Council. http://www.etsc.eu/documents/copy_of_Road%20deaths%20in%20Europe.pdf

ETSC (2007). Social and economic consequences of road traffic injury in Europe. ETSC, Brussels.

FHWA (2009a). Field Operations Guide for Safety/Service Patrols. *Report FHWA-HOP-10-014*, Federal Highways Administration, Washington DC.

FHWA (2009b). Field Operations Guide for Safety/Service Patrols - Checklists, Federal Highways Administration, Washington DC.

FHWA (2010a). IntelliDrive. *Public Roads, July/August 2010*, p18-22.

FHWA (2010b). Best Practices in Traffic Incident Management. *Report FHWA-HOP-10-050*, Federal Highways Administration, Washington DC.

Flemisch F (2010). Towards highly automated driving: intermediate report on the HAVEit-joint system. *Proc. Transport Research Arena (TRA) 2010 conference,* Brussels, 7-10 June 2010.

Frith B A (1999). The estimation of recurrent congestion and congestion due to roadworks and incidents: 1995/96 to 1998/99. *TRL Report PR/TT/160/99*. Transport Research Laboratory, Crowthorne House, Wokingham, UK.

Fullerton M, Leonhardt A, Assenmacher S, Baur M, Busch F, Beltran C, Minguez JJ, Paadin T (2010). Simulation study on improving traffic safety and traffic flow in the vicinity of a motorway accident through vehicle-to-vehicle communication. *Proc. Road Traffic Information and Control conference*, London, May 2010.

HATO (). http://www.highways.gov.uk/knowledge/601.aspx

HAVEit (2010). Brochure. http://www.haveit-eu.org/

Herrenda D (2010). De-fragmenting Europe. *ITS International March/April 2010*.

Highways Agency (2007). Standard Incident Management Framework. April 2007. http://www.highways.gov.uk/business/15015.aspx

Highways Agency (2009). Traffic Incident Management Guidance Framework Aide Mémoire. August 2009. http://www.highways.gov.uk/business/documents/TIMGF_Content.pdf

ITS International (2010). Traffic safety practices and strategies in US lagging behind other countries. http://www.itsinternational.com/news/article.cfm?recordID=18874

Konstatinopoulou L (2010). Non technical barriers to deployment of cooperative systems. *Proc. Transport Research Arena (TRA) 2010 conference*, Brussels, 7-10 June 2010.

Taylor N B (2006a). Evaluating congestion caused by Abnormal Loads. *TRL Published Project Report PPR194.* Transport Research Laboratory, Crowthorne, UK.

Pre-DRIVE C2X (2010). http://www.pre-drive-c2x.eu/index.dhtml

Stevens A and Hopkin J (2010). UK eCall impact assessment. *TRL Report PPR 470.* Transport Research Laboratory, Crowthorne, UK.

Taylor N B (2006b). Modelling congestion caused by Abnormal Loads. *TRL Published Project Report PPR196.* Transport Research Laboratory, Crowthorne, UK.

Taylor N B (2010). Defining best practice in European traffic incident management. *Proc. Transport Research Arena (TRA) 2010 conference*, Brussels, 7-10 June 2010.

TISPOL (2010). European Traffic Police Network. http://www.tispol.org

Treiber M, Kesting A and Wilson R (2009). Reconstructing the traffic state by fusing of heterogeneous data. http://arxiv.org/abs/0909.4467v1

TRL (2006). *Large Goods Vehicle Accidents on HA Roads*. Leaflet. Transport Research Laboratory, Crowthorne, UK.

UK Resilience (2010). http://www.cabinetoffice.gov.uk/ukresilience/emergencies.aspx

Verkeerscentrum Nederland (2010). Incident Management documentation (including 'red-blue' book). VCNL Rijkswaterstaat. http://www.incidentmanagement.nl//index.php?option=com_content&task=view&id=141&Itemid=135

Visintainer F (2010). Cooperative systems for road safety: the SAFESPOT integrated project. *Proc. Transport Research Arena (TRA) 2010 conference,* Brussels, 7-10 June 2010.

VKRC (2010). Verkeersregelaar Centrale - Incident Management http://www.vkrc.nl/index.php/deverkeersregelaarscentrale/verkeersregelaars/incident-management.html

Walker R, Stevens A, Anjum O, Suriarachchi M and McNamara K (2010). Benefits of automatic crash notification for traffic management. *Proc. Road Traffic Information and Control conference*, London, May 2010.

Weg-Wijzer(). http://www.weg-wijzer.nl/verkeersregelaar.html

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