EasyWay Harmonising European ITS Services and Actions

Traffic Management Services

INCIDENT WARNING AND MANAGEMENT

Deployment Guideline

TMS-DG05-08 | VERSION 02-00-00 | DECEMBER 2012

EasyWay is a trans-european project co-financed by the European Commission (DG MOVE)

www.easyway-its.eu

Contact

Coordinator	Marjolein Masclee, Rijkswaterstaat, The Netherlands, Marjolein.masclee@rws.nl Paola Mainardi, SINA, Italy, paola.mainardi@sina.co.it
Coordinator support	Alessandro Javicoli, SINA, Italy, alessandro.javicoli@sina.co.it Annette Zwiers, ARS T&TT, The Netherlands, zwiers@ars.nl

Preamble

EasyWay is a cooperation of road authorities and road operators from 27 European countries that have teamed up to unlock the benefits of cooperation and harmonisation in the deployment of Intelligent Transport Systems (ITS) on Europe's major road network. ITS as a technology is a known contributor to sustainable mobility in terms of improved safety, efficiency and reduced environmental impact. Nevertheless, fragmented deployment on a national level will fail to deliver seamless European services and will not contribute to a coherent European Transport network. The European Member States have consequently launched the EasyWay project together with the European Commission as a platform to harmonise their ITS deployments.

This document has been drafted by EasyWay as part of the set of documents containing the 2012 version of the EasyWay Deployment Guidelines (DG 2012). These guidelines have been developed by EasyWay experts and practitioners. They have undergone a thorough review by international domain experts in an intense peer review exercise and they have been validated by the participating Member State Partners of EasyWay in an extensive formal Member State consultation process, which finally led to their adoption as basis for all deployment activities in future EasyWay phases.

EasyWay as a project is not a standardisation body, nor does it have any power to legally constrain the Member State in their national deployment activities. It is therefore crucial to understand that these documents are neither technical standards, nor are they specifications as they would be required for such cases, e.g. as currently developed by the European Commission as their part of the implementation of the ITS Directive 2010/40/EU. But since a certain level of strictness in compliance is required to achieve the intended goal of the EasyWay Deployment Guidelines – harmonisation and interoperability in Europe – the guideline documents are written in a way that clearly defines criteria that deployments have to fulfil in order to claim overall compliance with the guideline.

Although not legally binding in any sense, compliance may be required for the eligibility of deployments in future ITS road projects co-funded by the European Commission. Deviation from compliance requirements may nevertheless be unavoidable in some cases and well justified. It is therefore expected that compliance statements may contain an explanation that justifies deviation in such cases. This is known as the "comply or explain" principle.

Although not standards themselves, the EasyWay DG2012 Deployment Guidelines in some cases do mention – and sometimes require – the use of such standards. This is the case in particular regarding the use of the CEN/TS 16157 series of technical specifications for data exchange ("DATEX II"). Although standardised data exchange interfaces are a powerful tool towards harmonised services in Europe, it must be understood that real world deployments have to fit into existing – and sometimes extensive – infrastructures and investment in these infrastructures must be protected. It is therefore important to note that the use of DATEX II mentioned below as a MUST is referred to implementation of "new" data exchange systems and not the utilisation of the existing ones, unless these latter affect harmonisation of deployments or interoperability of services.

Service at a glance

SERVICE DEFINITION

Incident management is defined as the implementation of a systematic, planned and coordinated set of responsive actions and resources to prevent accidents in potentially dangerous situations and to handle incidents safely and quickly. It proceeds through a cycle of several phases: from incident detection to restoration of normal traffic conditions, including the use of immediate and advance notice of possible dangers or problems, i.e. warnings, in order to prevent accidents.

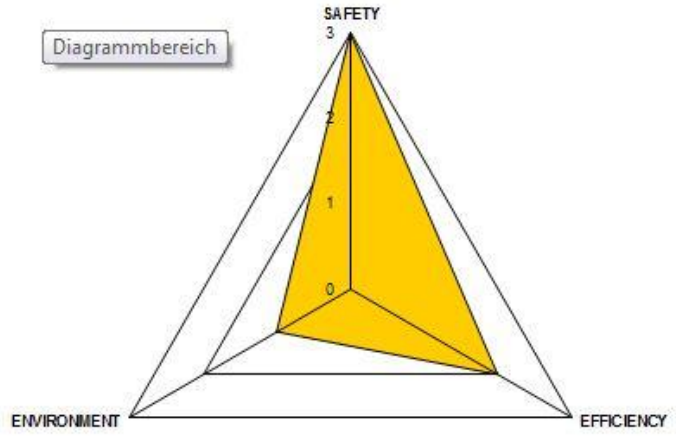
SERVICE OBJECTIVE

Incident warning and management have two main goals:

a) to prevent or minimize the risk of incidents or the consequences of incidents;

b) to manage and resolve incidents in a safe, effective and expeditious way regarding the following three aspects in order of priority as follows: safety, mobility of traffic flow and control and repair of damage.

SERVICE BENEFIT RADAR



EUROPEAN DIMENSION

The European dimension is to provide a common approach for IM on the TEN-T Roads, thereby harmonising national IM as well as improving the conditions for cross-border IM activities and the sharing of IM experiences and best-practices.

Harmonisation of future deployments should be performed in three main areas:

1. Improved cooperation and coordination between road authorities and IM partners in each country based on formalised agreements;

2. Similar European definitions of incident management stages and evaluation methodologies;

3. Road user oriented aspects such as systems for incident detection and location, traffic information to road users, requirements/expectations to road user behaviour and time of arrival of IM responders.

Table of Content

List of figures and tables

List of abbreviations

IM	Incident Management
DG	Deployment Guideline
ESG	Expert and Study Group
TERN	Trans European Road Network
HGV	Heavy Goods Vehicle
ICT	Information and Communications Infrastructure
ITS	Intelligent Transport Systems
VMS	Variable Message Sign
LoS	Level of Service
OE	Operating Environment
TEN-T	Trans-European transport network
TCC	Traffic Control Centre
EU	European Union
RDS-TMC	Radio Data System - Traffic Message Channel
UML	Unified Modelling Language
CLF	Common Look and Feel
ERT	Emergency Roadside Telephone
R.E.2	Consolidated Resolution on Road Signs and Signals
FR<#>	Functional requirement <number>
OR<#>	Organisational requirement <number>
TR<#>	Technical requirement <number>
CL&FR<#>	Look and feel requirement <number>
LoSR<#>	Level of service requirement

1 Introduction

1.1 The concept of the EasyWay Deployment Guidelines

1.1.1 Preliminary note

This document is one of a set of documents for the EasyWay project, a project for Europe-wide ITS deployment on main TERN corridors undertaken by national road authorities and operators with associated partners including the automotive industry, telecom operators and public transport stakeholders. It sets clear targets, identifies the set of necessary European ITS services to deploy (Traveller Information, Traffic Management and Freight and Logistic Services) and is an efficient platform that allows the European mobility stakeholders to achieve a coordinated and combined deployment of these pan-European services.

EasyWay started in 2007 and has since established a huge body of knowledge and a consensus for the harmonised deployment of these ITS services. This knowledge has been captured in documents providing guidance on service deployment - the EasyWay Deployment Guidelines.

The first iteration of the Deployment Guidelines mainly captured best practice. This strongly supported service deployment within EasyWay by:

- making EasyWay partners in deployment aware of experiences made in other European deployment programmes.
- helping to avoid making errors others had already made
- reducing risk and facilitating efficient deployment by highlighting important and critical issues to consider

Meanwhile, this best practice has already successfully contributed to ITS deployments across Europe. It is now possible to take the logical next step and actually start recommending those elements of service deployment that have proven their contribution to both the success of the local deployment, as well as the European added value of harmonised deployment for seamless and interoperable services.

1.1.2 Applying Deployment Guidelines – the “comply or explain” principle

The step from descriptive best practice towards clear recommendations is reflected in the document structure used for this generation of the Deployment Guidelines. Apart from introduction and the annexes that cover specific additional material, the Deployment Guidelines consist of two main sections:

Part A – this part covers the recommendations and requirements that are proven to contribute to successful deployment and have been agreed by the EasyWay partners as elements that should be part of all deployments of this particular service within the scope of EasyWay. Thus, the content of this section is prescriptive by nature. EasyWay partners are expected to ensure that their deployments are compliant with the specifications in this section. Wherever concrete circumstances in a project do not allow these recommendations to be followed fully, EasyWay partners are expected to provide a substantial explanation for the need for this deviation. This concept is known as the “comply or explain” principle.

Part B – this part offers an opportunity to provide more valuable but less prescriptive information. Supplementary information may be contained including – but not limited to – regional/national examples of deployment and business model aspects like stakeholder involvement or cost/benefit analysis results.

1.1.3 Use of Language in Part A

It is essential for every prescriptive document to provide specifications in a well-defined and unambiguous language. There are various definitions that clarify the use of particular words (such as those listed below) within their prescriptive texts.

For the purpose of the EasyWay Deployment Guidelines, the well-established provisions of the RFC 2119 (http://www.ietf.org/rfc/rfc2119.txt, see (1)) are used, which is used to specify the basic Internet standards:

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119.

An overview of the keywords, their meaning and the possible answers in the context of part A provides the following table. In general the keywords in brackets are possible, but their use is not recommended in order to avoid confusion which may arise as a consequence of different common linguistic usage of the terms in the different EU member states.

Requirement wording	Meaning in RFC 2119	Meaning in EasyWay	Possible checklist answers
MUST (REQUIRED, SHALL)	the definition is an absolute requirement	there may exist insurmountable reasons to not fulfill (e.g. legal regulations…)	**fulfilled: yes** **or** **Fulfilled: no - explanation of insurmountable reasons**
MUST NOT (SHALL NOT)	the definition is an absolute prohibition		
SHOULD (RECOMMENDED)	there may exist valid reasons in particular circumstances to ignore a particular item, but the full implications must be understood and carefully weighed before choosing a different course.	The Definition is very close to a "MUST", "MUST NOT" Meaning in EasyWay conform to RFC 2119	**fulfilled: yes** **or** **Fulfilled: no - with explanation**
SHOULD NOT (NOT RECOMMENDED)	there may exist valid reasons in particular circumstances when the particular behavior is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behavior described with this label		
MAY (OPTIONAL)	The item is truly optional. One deployment may choose to include the item because of particular local circumstances or because it is felt to deliver a special added value	Meaning in EasyWay conform to RFC 2119	**fulfilled: yes - with explanation** **or** **Fulfilled: no**

Table 1: Part A - requirement wording

Note: the capitalisation of these keywords that is frequently used in IT standards is not recommended for EasyWay Deployment Guidelines.

The use of this 'requirements language' allows the direct transfer of the requirements stated in part A to a compliance checklist.

The following paragraph gives an example for a functional requirement:

Functional requirement:

- **FR2:** Data and information collected by both automatically and non-technical sources must be based upon both a consistent geographic reference model and a time validity model, which both **must** be part of data description.

Beneath "Requirement" a new semantic element "Advice" is proposed for part A, which has not the character of a hard requirement but of a "recommendation" and hence must not be listed in the compliance checklist. "Advice" is not immediately related to the three pillars of ITS-service harmonization (Interoperability, Common look & feel, Quality criteria) but to "inner features" of an ITS-service. Nevertheless such an element delivers a European added value and hence should be addressed by the deployment guidelines.

The notation for using the advice element in the text is as follows:

Organisational advice:

- Clear definitions of organisational aspects are a crucial precondition for the successful implementation of a "Forecast and real-time event information service" and should be documented and accepted of all involved parties/partners in form of a Common partner arrangement/MoU - Memorandum of understanding, which establishes the details of co-operation.

1.2 ITS-Service Profile

1.2.1 ITS-Service Strategy

1.2.1.1 General Service Description

Incident management is defined as the implementation of a systematic, planned and coordinated set of responsive actions and resources to prevent accidents in potentially dangerous situations and to handle incidents safely and quickly. It proceeds through a cycle of several phases: from incident detection to restoration of normal traffic conditions, including the use of immediate and advance notice of possible dangers or problems, i.e. warnings, in order to prevent accidents.

Definitions:

- An incident is a situation on the road that is not expected or foreseen by the road user and which may, or may not, lead to an accident. An incident impacts the safety and/or capacity of the road network for a limited period of time. Incidents range from breakdowns, to debris on carriageway, road works, collisions between vehicles or with obstacles and accidents involving hazardous materials.
- An accident implies a collision, damage or a personal injury and can be considered as a specific type of incident.
- A warning is an immediate or advance notice of a possible danger or problem (that can also be given to the road users separately from IM)
- IM partners are all organisations involved in Incident Management, e.g. police, fire brigades, ambulance services, recovery services, road authorities, network managers, TCC operators etc.
- IM responders are all people involved in Incident Management at the scene, e.g. police, fire brigades, ambulance services, recovery service, road operators etc.

1.2.1.2 What is the Vision?

Incident warning and management have two main goals:

- To prevent or minimize the risk of incidents or to prevent or minimize the consequences of incidents.
- To manage and resolve incidents in a safe, effective and expeditious way regarding the following three aspects in order of priority as follows: safety, mobility of traffic flow and control and repair of damage

1.2.1.3 What is the Mission?

Three aspects by order of priority:

- 1. Safety

Whenever an incident occurs, it also has an effect on the safety of people in the vicinity of the incident. Victims of the primary incident, IM responders and road users (upstream of the incident and on the other side of the road) are the most important risk groups exposed to additional risks, i.e. secondary incidents. Therefore IM must create the safest possible workplace at the scene of the incident to ensure the safety of IM responders, those involved in the incident and road users travelling past the incident scene. Measures must be taken to protect all involved from hazards at the incident scene, e.g., smoke and hazardous substances.

- 2. Traffic flow

IM must ensure that the traffic flow in the vicinity of the incident is safe and optimal. If necessary and possible, traffic must be diverted via other routes to relieve the incident area and safeguard the mobility of traffic flow. In this aspect, the goal of IM is to reduce delays and increase reliability for the road user. Traffic queues caused by incidents result in delays, disruption to public transport schedules, financial loss to freight operators and businesses and increased vehicle emissions due to traffic idling for extended periods of time. These are the reasons why incident management is considered such a high priority.

- 3. Control and repair of damage

IM must consider the consequences, including the economic cost incurred, of damage to the vehicles and loads involved in incidents, as well as the repair of possible damage to the road (surface, road equipment [e.g. safety barrier] and civil engineering structures), considering economic costs.

1.2.1.4 EasyWay harmonization focus

This EasyWay Deployment Guideline is focused on providing a common approach for IM on the TEN-T Roads, and thereby harmonising national IM as well as improving the conditions for cross-border IM activities and the sharing of IM experiences and best-practice.

The focus of the harmonisation of future deployments should be undertaken in three main areas:

- Improved cooperation and coordination between road authorities and IM partners in each country based on formalised agreements;
- Similar European definitions of incident management stages and evaluation methodologies;
- Road user oriented aspects such as systems for incident detection and location, traffic information to road users (warning actions), requirements/expectations of road user behaviour and arrival times of IM responders (emergency actions).

1.2.1.5 Distinctiveness from other ITS-services

The Deployment Guideline on Incident Management and Incident Warning is not comparable to traffic management services as described in the other deployment guidelines. Together with the Deployment Guideline "Traffic management plan service for corridors and networks", its nature is a management service which uses and applies other services. This is due to the nature of the IM process in which cooperation between IM responders including a clear description of the roles and responsibilities of the different IM responders plays an important role. Therefore, some requirements relate to the non-ITS-aspects of IM. They are meant to use ITS in a more efficient and more effective way.

Traffic Management service, in relation to IM, becomes more complex in situations where other ITS-services are involved like Dynamic Lane Management, Hard Shoulder Running, Variable Speed Limit and HGV Overtaking Ban. Extra steps in the IM process will be necessary. Traffic Management Services in the case of incidents also include actions, for e.g., diversion routes in the case of incidents with wide-scale impact on multiple regions.

1.2.2 Contribution to EasyWay Objectives

1.2.2.1 Service radar

The graph below provides a quantification of the added value of "Incident Warning & Management" services regarding the three main objectives of EasyWay which are: safety, efficiency and environment. The applied scales for the service radars are based on an expert view and not on specific scientific analysis.

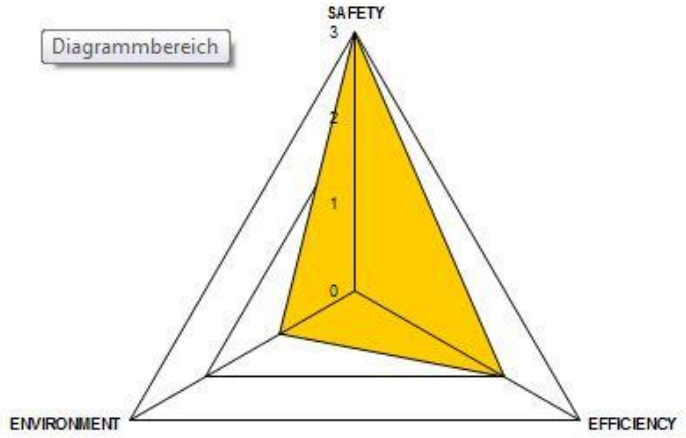


Figure 1: Service radar “Incident Warning and Management”

1.2.2.2 Safety

The application of measures for Incident Warning and Management offers the opportunity to optimize road safety where dangerous situations occur suddenly. They also reduce the risk of congestion and accidents. The impact analysis of existing systems confirms the positive effect on traffic safety.

1.2.2.3 Environmental impact

The effective use of Incident Warning and Management measures can reduce incident-related congestion and prevent secondary incidents (and thus additional congestion caused), thereby reducing delay, noise and polluting emissions.

1.2.2.4 Network efficiency

Demand-oriented incident warning and management improves the flow of traffic on the network concerned. In this way sudden braking manoeuvres and/or rear-end collisions without braking can frequently be avoided. This can significantly reduce the level of congestion, delay and cost due to these negative factors, including costs associated with asset restoration..

1.2.3 Current status of deployment

The state of the art reflects the classification of means and measures needed to provide an incident warning and management service across Europe.

The level of IM deployment varies across Europe. Many countries have some forms of IM primarily covering motorways and main roads. Agreements are typically regional or local and occasionally nationwide. In some countries IM coverage includes road works and recurring congestion. In other countries only unforeseen events which require action by different IM responders are classified as incidents.

There are a number of applications for the deployment of these services in Europe and some results and effects of these are presented in the part B of this guideline.

1.2.4 European Dimension

In terms of the operating environments for IM, the typical application of the service is the TEN-T Roads network which mainly comprises toll motorways or motorways in general, but also includes urban rings and/or peri-urban networks.

Today the TEN-T Roads show a wide range of differences in the deployment of road infrastructure for the detection of incidents as well as the measures available to handle incidents. This wide range of differences can also be seen between countries and regions in the same operational environment and therefore the focus of the different responsibilities of IM partners is very fragmented.

An element that contributes to achieving a harmonization at the European level is the DATEX data profile. It is important to acknowledge the availability of incident data for service providers which DATEX supplies in a harmonised format from a European dimension.

Among the several existing means the Traffic Message Channel (RDS-TMC) using FM radio waves is a commonly used system to deliver traffic and travel information to road users. It has a strong European dimension because it is based on a common set of messages which are transmitted in the user language, thus resolving the problem of different languages.

For Variable Message Signs a common European technical standard exists, as noted in the relevant paragraph. For networked roadside markers, a standard might be useful to realise a common user interface. This standard might define the user needs, the functional architecture of the warning system and the general physical architecture, eventually including the features of the roadside markers or panels and the flashing features (e.g., type of lights, frequencies).

The characteristics and deployment of future on-board message transmission needs to be analysed and followed by the stakeholders involved (road operators, communication operators and car manufacturers).

2 Part A: Harmonization Requirements

2.1 Service Definition

Incident management is defined as the implementation of a systematic, planned and coordinated set of responsive actions and resources to prevent accidents in potentially dangerous situations and to handle an incident safely and quickly. It proceeds through a cycle of several stages: from incident detection to the restoration of normal traffic conditions, including the use of immediate and advance notice of possible dangers or problems, i.e. warnings, in order to prevent accidents.

2.2 Functional Requirements

2.2.1 Preliminary remark

To realize IM as a traffic management measure, the parties involved have to go through three phases in an iterative process.

- In phase 1 the cooperating parties jointly identify who should be responsible for what. They define a common approach with common goals and common priorities.
- Phase 2 relates to the practical implementation of the agreement between the IM partners. This includes the logging and monitoring of incidents which will serve as input for phase 3.
- In phase 3 the IM partners should continuously monitor the quality of IM. The lessons learned lead to improved and enhanced procedures for elements like communication, traffic management, finances and education.

2.2.2 Functional architecture

In the process of incident management before, during and after an incident, the following functional requirements to be fulfilled by the IM-partners can be distinguished:

Functional requirements:

- **FR1:** Secondary accident prevention (to prevent further accidents as a result of a first accident or other incidents): if VMS are available, measures **must** be taken to warn road users of incidents ahead (e.g. traffic jams, limited availability of the crossing section, accident, etc.).
- **FR2**: Detection/Discovery: Measures **should** be taken to detect incidents as early as possible in order to initiate early warnings and incident management. Detection can be done through both technology and human forces.
- **FR3**: Verification: the identification of the nature, accurate location and impact of an incident (e.g. the number of cars/HGVs involved, number of victims, damage, and dangerous goods) **should** be communicated between IM partners.
- **FR4**: Clearance of the road: measures **should** be taken to enable IM responders to gain access to the incident. To enable restoration to normality the incident scene **should** be cleared, so that traffic flow can be restored.
- **FR5**: Traffic management: If ITS is available at the incident scene, traffic management measures **must** be taken at the start of the IM process e.g. dynamic lane closure, speed control, rerouting.
- **FR6**: Rescue: emergency (medical) assistance **must** be provided by IM responders, as defined in the safety measures protocol.
- **FR7**: Information to road users: road users **may** be warned about the impact of the incident e.g. duration, diversion, road blockage, traffic management measures.
- **FR8**: Site investigation: investigation **may** be carried out on the cause of the incident.

- **FR9**: Salvage/Recovery: Measures **should** be taken to recover broken down vehicles. In case of HGVs or professional users, an estimation of the economic value of the load as opposed to the socioeconomic costs of the road closure may be made to determine the salvage approach.
- **FR10**: Repair of road damage: If an incident has caused damage to the road or roadside equipment which may influence the safety level of road users, measures **should** be taken to repair the damages and/or safeguard the area.
- **FR11**: Logging and monitoring reports **should** be produced, containing information about the nature, location and impact of the incident.
- **FR12**: Evaluations and proposals for improvement **may** be analyzed and used to optimize the IM process.

2.3 Organisational Requirements

Incident management typically involves many different partners like the road authorities, road operators (public or private), the police, the fire brigade, ambulance services, recovery services and the media.

The cooperating parties jointly identify who should be responsible for what. They define a common approach with common goals and common priorities.

Organisational requirements:

- **OR1**: For the effective functioning of the IM process, all IM partners **must** cooperate not only during incidents but also in planning and evaluation. This ensures the continuity and the enhanced quality of the IM process.
- **OR2**: Protocol: a safety measures protocol **must** be prepared, defining common and agreed safety measures for IM responders at the incident site as well as agreement on roles and responsibilities of cooperating parties.
- **OR3**: The IM partners **should** appoint one IM Coordinator, who has final responsibility on the scene. The IM Coordinator can vary between IM partners, depending on the type of incident.

There are a number of relevant laws, directives and guidelines, often defined at national level, that have to be considered and respected when an accident occurs and the responsive actions are activated. For example removing damaged vehicles (incidents), stalled vehicles and lost cargo (spilled loads) from roads is based on laws in the private domain a result of a tort (wrongful act) committed against the road operator.

It is essential to take this legal framework into account in the organization and the cooperation of multiple partners.

2.4 Technical Requirements

2.4.1 ICT Infrastructure requirements

The basis for incident warning, and consequently for its management, is the monitoring of real time traffic conditions (including weather and road conditions) and the detection of an incident.

As stated in FR2, detection can be done both through both technology and by human force. If technology is used to detect incidents, the following technologies **could** be used on the TEN-T Roads:

- Sensors
- Cameras
- e-Call[1]
- Floating car data

There are, between the detection systems, those placed on or embedded in the road surface and those above the surface, sometimes recognised also as contactless systems.

As sensors for the detection of traffic data, a number of solutions or detectors may be applied of which the most commonly deployed technologies are:

- inductive loops
- magnetic sensors
- microwave radars
- laser radars
- passive infrared
- ultrasonic sensors
- instruments based on acoustic and video image processing.

[1] In case of a crash, an eCall-equipped car automatically calls the nearest emergency centre. Even if no passenger is able to speak, e.g. due to injuries, a 'Minimum Set of Data' is sent, which includes the exact location of the crash site. Shortly after the accident, emergency services therefore know that there has been an accident, and where exactly, cutting emergency services response time.

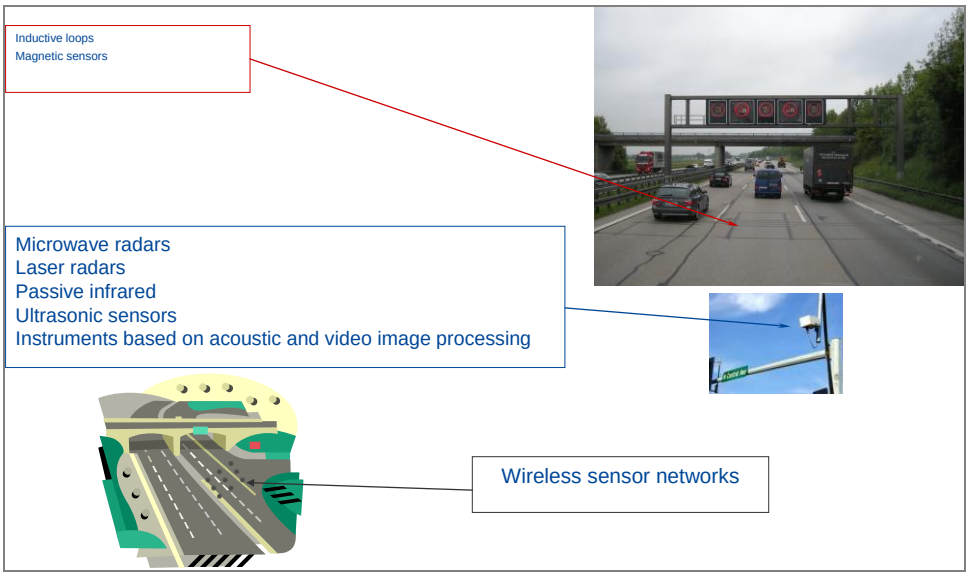


Figure 2: Traffic monitoring technologies

It is important to clarify that the technical and technological equipment such as sensors, cameras, VMSs, etc., are used both for incident detection and warning as well as for the daily management of the network.

Technical requirement:

- **TR1**: The traffic control centre (TCC) - or person/body in charge - **must** monitor the functions and operational states of the equipment.
- **TR2**: When handling an incident, TCC **should** avoid focussing completely on the incident. The TCC should continue to monitor the traffic flow on the whole network.

2.4.2 Standards and Agreements: Existing and Required

2.4.2.1 Common standards

Technical advice:

- It is advised that the following standards, concerning technologies and systems related to incident warning and management service, are considered:
  - Vienna Convention for use on VMS, Annex IX of ECE/TRANS/WP.1/119/Rev.2 27 May 2010 (please refer to the requirement CL&FR6). EN 12966-1/2/3:2005. Road vertical signs. Variable message traffic signs.
  - Applicable national standards (see the annex)

2.4.2.2 DATEXII-Profiles

Interoperable interfaces between systems are essential for the delivery of many EasyWay objectives like continuity of services and cross-border traffic management cooperation. Hence, EasyWay has itself decided to actively contribute to the establishment of the required standardisation effort by launching a dedicated working group ESG5 and liaising with the relevant European standardisation body, namely with CEN TC278 WG8 (“Road Traffic Data”). The result of this cooperation is the “DATEX II” specification for interoperable machine-to-machine communication of ITS services, available as European Standard CEN/TS 16157. This specification is used throughout EasyWay for interoperable access to dynamic traffic and travel data.

One of the major deliverables of the DATEX II specifications is to offer a toolbox for applying one of the most common IT technologies for data definition, the Unified Modelling Language (UML, ISO/IEC 19501:2005).

What makes this so important is that providing one such formal data definition for each service supported by all implementations in EasyWay ensures technical interoperability ("Plug & Play") because interfaces generated from the same data definition are sure to be able to process the exchanged data.

This integration of the DATEX II profile in the DG provide a solid dimension in terms of service standardisation and harmonisation, this also guarantees the information exchange among traffic managers and the wide dissemination of traffic information and traffic management services thanks to the facilities for providing standardised DATEX II publications to service providers.

The Incident Warning and Management service is characterized by the following elements:

- a) The location of the incident
- b) The type of incident
- c) The actions taken by the road operators to face the incident

These elements and the Incident Warning and Management related elements must be described in the DATEX II Model as precisely as presented in this chapter:

The mapping of information related to Incident Warning and Management service into the DATEX II level A is easy. DATEX II has dedicated classes for this type of information.

These classes are specialisation of the SituationRecord class, hence the information regarding Incident Warning and Management shall be published via a SituationPublication.

Technical requirements:

- **TR3:** In the case that road operators have to exchange data requiring interoperability between two or more different organizations[2], they **must** enable their system to use DATEX II.

For more details see Annex B.

[2] In the TIS context, "organisations" mean Traffic and Traveller Data providers and Services providers.

2.5 Common Look & Feel

A common look and feel (CLF) concerns the road users ´expectations when they meet a situation where incident warning and management is required, like a breakdown or collision or traffic management measures activated to support IM.

Common look & feel requirements:

IT-measures

- **CL&FR1**: The road user must be aware of how to call for help. For IM there **must** be at least one of the following services available on the TEN-T Roads:
  - o Mobile coverage (to make it possible to call 112)
  - o Emergency Roadside Telephone (ERT) or SOS column/device
  - o eCall[3] (in future when it will be available in all vehicles)
- **CL&FR2**: VMS messages used for incident warning or traffic management **should** be harmonised. They provide information, for example about: accident ahead, debris/obstacles on the road, hazardous material on the carriageway, fog, wind, ice/snow.

Currently common icons at European level haven't been defined; however the following proposal is suggested.

- **CL&FR3**: In dangerous situations at least a danger warning **should** be used as a minimum.
- **CL&FR4:** If VMSs are available, warning signs **must** be used if possible.
- **CL&FR5:** In order to guarantee the harmonization, a danger warning sign **should** be used in accordance with prevailing national road codes and where applicable be in line with the requirements of the EW-DG for Variable Message Signs Harmonization VMS-DG01. For example:

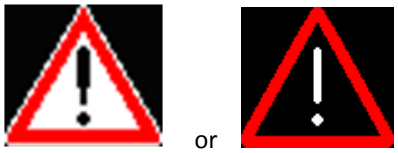


Figure 3: Examples of Danger Warning Signs as identified by ESG4

- **CL&FR6**: In addition, the type of incident **may** be clearly defined on the VMS (if the VMS is fitted with lines and alphanumeric characters). Some examples:

Figure 4: Some examples of incident warnings on VMS

- **CL&FR7**: If a single icon is not enough to ensure a driver's clear understanding, other danger warning signs **may** be used in accordance with prevailing national road codes and where applicable be in line with the requirements of the EW-DG for Variable Message Signs Harmonization VMS-DG01. Some examples of this are as follows:

Figure 5: Examples of Danger Warning Signs with supporting icon

[3] see footnote par.2.4.1

- **CL&FR8**: If it isn't possible to use a well know pictogram, like those represented above, the display of signs/pictograms on VMS or other end-user devices **should** be in accordance with prevailing national road codes and where applicable be in line with the requirements of the EW-DG for Variable Message Signs Harmonisation VMS-DG01:
  - o MS which ratified the 1968 Convention MUST respect the 1968 Convention and SHOULD consider the Consolidated Resolution on Road Signs and Signals (R.E.2);
  - o MS which did sign but not ratify the 1968 Convention SHOULD follow the 1968 Convention and also consider the R.E.2.

  It is up to the deploying road operator to ensure that real signs are well and widely understood by the road users.

Non- ITS measures

- **CL&FR9**: On sections where incident warning and management systems are implemented, the road user **must** be able to provide their location. This could be achieved by e.g. road number, direction and distance marker post information, ERT

Common look & feel advice:

- IM responders are advised to be recognizable to the road user as emergency services (for example via safety vests and IM vehicles).
- Public campaigns are recommend in order to educate road users on how to behave in an incident or when witnessing an incident or in case of approaching emergency services.

Figure 6: Examples of Driver Location Signs

2.6 Level of Service Definition

2.6.1 Preliminary remark

The scope of EasyWay is to provide Core European Services to the European road users. These services are harmonized in content and functionality, as well as in their availability: The road users shall be able to expect a certain services offer in a specific road environment. In order to provide a basis for the harmonization process EasyWay needs a tool to define such environments in an agreed manner. This tool is the Operating Environments – a set of pre-defined road environments combining physical layout of the road and the network typology with traffic characteristics.

In essence, EasyWay has agreed on a set of 18 pre-defined Operating Environments (OE) where each OE is a combination of three criteria:

- Physical characteristics – Motorways, other 3/4 lane roads or 2-lane roads
- Network typology – Corridor, Network, Link or Critical spot
- Traffic characteristics – Traffic flow and road safety situations (with optional additions)

For more information and details, visit http://www.easyway-its.eu/document-center/document/open/490/ and download the Guidance for Classifying the EasyWay Network into OE.

The "level of service" (LoS) can be defined as the amount, kind and quality of service that, on one hand, is appropriate to the needs and desires of the customers or users that a company - or a public body or agency - serves or wishes to attract and, on the other, is not high for the investments or costs of the company.

The service level therefore describes the quality levels of the service from the perspective of the user of the services or the road operator providing the service.

The service level is also expressed as "a percentage of a goal", for example, the percentage of time that a network or system is operative or the percentage of successful transactions processed[4].

The service level process implies the following steps:

1) Definition of goals: e.g., the time for emptying a tunnel in safe conditions; number of vehicles which pass through a gate within a certain time to identify expected waiting times in queuing conditions;

2) Fixing one or more levels of quality, which may vary according to the goal that is pursued? Consequently, it could be consequently a % (of drivers, of vehicles; in this case the level of efficiency of the service), a waiting time (in this case the level of quality of the service), time for passing from the dangerous situation into a safe situation (in this case the level of efficiency of the service associated to quality without any problem or deviation from a standard procedure);

3) Fixing the parameters and methods for analysing how to evaluate the level of service.

[4] In telecommunications applications, especially in telephonic call centres, it refers to the achievement of specific goals for customer handling. These goals are usually expressed in terms of call-answering percentage, percentage of calls dropped, average hold time, average call duration and other measures of efficiency and productivity.

2.6.2 Level of Service Criteria

Levels of Service: Incident Warning and Management				
Core Criteria		**A**	**B**	**C**
RESPONSE TIMES		Informal No formalized Service Level Agreements on response times (example: formal agreement to arrive at the incident scene within 30 minutes.)	Individual Every IM partner has its own independent Service Level Agreements.	Coordinated The Service Level Agreements are coordinated to limit the time to resolve an incident.
INFORMATION QUALITY	**FREQUENCY of information service (with VMS, media, navigation systems, etc.)**	Messages are updated every hour	Messages are updated every 30 minutes	Messages are in real time (updated at least every 5 minutes)
	CONTENT of the information	Information about the kind of alert and location (e.g. incident on A4)	Detailed information about the kind of alert, the exact location of the event, the possible consequences (e.g. incident on A4 between Exit 1 and 2, traffic jam 5 km is growing, take diversion A)	Information is customized according to the position of user (e.g. navigation systems could give several diversion options)
	RELAY TIME of the information (from the detection of the incident)	Information within 1 hour	Information within 30 minutes	Real time information (max. 5 minutes delay)
SAFETY OF THE ROAD USER recognisability of the incident scene and of IM-partners; protection of the incident scene		Recognisability of cars is not co-ordinated and IM responders all wear safety jackets Incident scene is indicated (e.g. via a red cross or a VMS warning message), but road users can access the incident scene	Cars of IM responders have clearly visible logos and IM responders all wear safety jackets Incident scene is indicated and protected in such a way that it is difficult for other road users to access	Cars of IM responders are recognizable e.g. via uniform stripes and IM-partners all wear safety jackets Incident scene is indicated and protected in such a way that other road users are not able to access (the barrier of) the incident scene

Table 2: Level of Service

2.6.3 Level of Service Criteria related to Operating Environment

LoSR1: Given that pre-deployment surveys and evaluations provide the necessary evidence to proceed with deployment, the minimum and optimum LoS **should** respect the Level of Service to Operating Environment mapping table. LoS/OE does not imply any obligation to deploy ITS services. However if services are deployed they **should** comply with the following table.

INCIDENT MANAGEMENT Criteria for the Levels of Service [reference TMS - DG08]			EasyWay OPERATING ENVIRONMENT																
			C1	T1	T2	T3	T4	R1	R2	R3	R4	R5	R6	R7	R8	S1	S2	N1	N2	P1
Response times	C	Coordinated	o													o	o	o	o	
	B	Individual	m	o	o	o	o	o	o	o	o	o	o	o	o	m	m	m	m	o
	A	Informal		m	m	m	m	m	m	m	m	m	m	m	m					m
Information quality FREQUENCY of information service (with VMS, media, navigation systems, etc.)	C	Messages are in real time (updated at least every 5 minutes)	o													o	o	o	o	
	B	Messages are updated every 30 minutes	m	o	o	o	o	o	o	o	o	o	o	o	o	m	m	m	m	o
	A	Messages are updated every hour		m	m	m	m	m	m	m	m	m	m	m	m					m
Information Quality CONTENT of the information	C	customized	o													o	o	o	o	
	B	kind of alert, the exact location of the event, the possible consequences	m	o	o	o	o	o	o	o	o	o	o	o	o	m	m	m	m	o
	A	kind of alert and location.		m	m	m	m	m	m	m	m	m	m	m	m					m
Information quality RELAY TIME of the information (from the detection of the incident)	C	Real time information (max. 5 minutes delay)	o													o	o	o	o	
	B	Information within 30 minutes	m	o	o	o	o	o	o	o	o	o	o	o	o	m	m	m	m	o
	A	Information within 1 hour		m	m	m	m	m	m	m	m	m	m	m	m					m
Safety of the road user: recognizability of the incident sceneand of IM partner. protection of the incident scene	C	All equipment recognizable, all wear safety jackets, IM scene is fully protected.	o													o	o	o	o	
	B	All equipment recognizable, all wear safety jackets, IM scene is protected, but not fully	m	o	o	o	o	o	o	o	o	o	o	o	o	m	m	m	m	o
	A	Recognizability not coordinated, all wear safety jackets and IM scene is indicated, but open.		m	m	m	m	m	m	m	m	m	m	m	m					m

Recommendations for LoS per OE:			
M	Minimum LoS recommended	O	Optimum LoS recommended
OM	Minimum = Optimum	NA	Non applicable

Table 3: Level of Service to Operating Environment mapping table

These requirements apply only to deployments to be carried out by EW or its successor process in 2013 or later on the OE in question.

OE	Explanation
C1	critical spots, local flow-related traffic impact and/or potential safety concerns
T1	motorway (link), no flow-related traffic impact and no major safety concerns
T2	motorway (link), no flow-related traffic impact, potential safety concerns
T3	motorway (link), seasonal or daily flow-related traffic impact, no major safety concerns
T4	motorway (link), seasonal or daily flow-related traffic impact, potential safety concerns
R1	two-lane road (link), no flow-related traffic impact, no major safety concerns
R2	two-lane road (link), no flow-related traffic impact, potential safety concerns
R3	two-lane road (link), seasonal or daily flow-related traffic impact, no major safety concerns
R4	two-lane road (link), seasonal or daily flow-related traffic impact, potential safety concerns
R5	three-/four-lane road (link), no flow related traffic impact, no major safety concerns
R6	three-/four-lane road (link), no flow related traffic impact, potential safety concerns
R7	three-/four-lane road (link), seasonal or daily flow related traffic impact, no major safety concerns
R8	three-/four-lane road (link), seasonal or daily flow related traffic impact, potential safety concerns
S1	motorway corridor or network, at most seasonal flow-related impact, possibly safety concerns
S2	motorway corridor or network, daily flow-related traffic impact, possibly safety concerns
N1	road corridor or network, at most seasonal flow-related traffic impact, possibly safety concerns
N2	road corridor or network, daily flow-related traffic impact, possibly safety concerns
P1	peri-urban motorway or road interfacing urban environment, possibly safety concerns

OE type	Number	Flow-related traffic impact				Potential safety concerns	
		NO	SEASONAL	DAILY		NO	YES
Critical spots							
C	1		X	X	and/or		X
Motorway links							
T	1	X			and	X	
	2	X			and		X
	3		X	X	and	X	
	4		X	X	and		X
Road links							
R 2 lanes	1	X			and	X	
	2	X			and		X
	3		X	X	and	X	
	4		X	X	and		X
R 3 or 4 lanes	5	X			and	X	
	6	X			and		X
	7		X	X	and	X	
	8		X	X	and		X
Motorway corridor or network							
S	1		X		and		(X)
	2			X	and		(X)
Road corridor or network							
N	1		X		and		(X)
	2			X	and		(X)
Peri-urban motorway or road							
P	1				and		(X)

Table 4: Legend - EasyWay Operating Environments for Core European ITS Services.

3 Part B: Supplementary Information

EasyWay Deployment Guidelines are twofold:

- *Part A elaborates on the content of the ITS service addressed, including the entire deployment framework including Requirements and Levels of Services.*
- *Part B is an appendix of educational content. Its objective is to illustrate part A with examples and feedback from deployments in the field.*

This lively chapter is subject to continuous development and update. It consists in a database of national practices and experiences which, as cross-fertilisation material, can benefit any road operator in Europe.

Bearing in mind the cyclic nature of the elaboration of EasyWay Deployment Guidelines, one can assume that the first edition of the 2012 Guidelines will not yet include users' experience on its content. Forthcoming ITS deployments based on part A of this Deployment Guideline will generate feedback which will in-turn be integrated into the next revised version of part B.

3.1 Examples of deployment

3.1.1 Example Italy

GENERAL INFORMATION

- Name of service/project: European driver-oriented SOS system for Incident Management
- Name of operator/organisation: Autostrada Brescia-Padova SpA
- Web link: www.autobspd.it
- Contacts: pbarzanti@autobspd.it
- Other: sophia.chirskaya@hotmail.it
- Applicable Deployment Guideline: TMS DG05-08 Incident Warning and Management

GEOGRAPHICAL ASPECTS

- Country: Italy
- Region of implementation: CORVETTE
- Networks concerned: Motorway
- Deployment indicators: 10 Numbers of location on the TERN

SERVICE DESCRIPTION

- Problem(s) addressed / Objectives (Relation to EW objectives. Background/motivation to the ITS application - basic question: WHY):
  - o Reduction of congestion
  - o Increase of safety
- ITS service description (Description of ITS application, example of systems used functionality and technologies used, users involved, location, context within wider ITS system, current status of the application. (maximum 50 words):

  A new emergency call and monitoring system on the entire motorway Brescia-Padova network (182 km), following a pilot in 2010-2011. An important peculiarity of the system is represented by the multi-lingual interface facilitating its usage by the European traveller. Functionalities: low consumption CPU, serial ports, USB, display drivers, temperature probes, ethernet port and SD card reader, VoIP, colour camera

with infrared LEDs, backlit display, the proximity sensor, the pre-recorded voice messages in 5 languages, transmission of information in digital mode, film with printed instructions for users in 5 main languages.

IMPLEMENTATION ASPECTS

- Duration (start, end): 10/02/2011 - 30/04/2011
- Lessons learnt / factor of success (Key lessons learnt in various aspects of the planning and implementation process; could be technical, institutional/organizational, legal, financial – basic questions: Was the implementation a success / Were the objectives met? Why? What could be done differently next time?):

  o Technical

  The low power consumption in stand-by mode of electronic components in connection with the operation centre allow to empower the device using solar panels, enhancing the sustainability of infrastructure. SOS emergency system is able to use different channels for transmission of data between the point of call (SOS column) and operation centre. In the specific case, the road data network was built on a SHDSL backbone that attests to the tollbooths. This allows to limit the "out of service" in the event of a failure at single location SOS or, in more serious cases to the devices between the one tollbooth and another A new system has less downtime in case of abnormality due to redundancy of data and power, as, using battery, it allows the operation of the SOS column until the intervention of a technician

  o Institutional/organisational: /

  o Legal: /

  o Financial: /

- Impacts assessment / results (Description of impacts in terms of safety, travel efficiency, environmental impacts, security, traffic management…):

  The main goal of the pilot project - to check out the effectiveness in field of a new system - is successfully achieved. The pilot demonstrates the reduction of the reaction times both from operators and users thanks to improved data-transmission features of the SOS system, increasing of effectiveness by addressing also foreigners with multilingual answers and enhancing of functionality due to alternative types of energy supply allowing a remote control of the motorway stretch and a localisation of a failure on the single device without a block-out of the whole system. Furthermore thanks to the pilot experience some weaknesses in the telecommunication part of the system could be identified and solved, allowing a final achievement very effective and satisfactory.

REFERENCES

Documentation available on the project:

- Title: Ex-ante Evaluation Report Innovative European Driver-oriented SOS System
- Contact: pbarzanti@autobspd.it
- Language: English

ILLUSTRATIONS

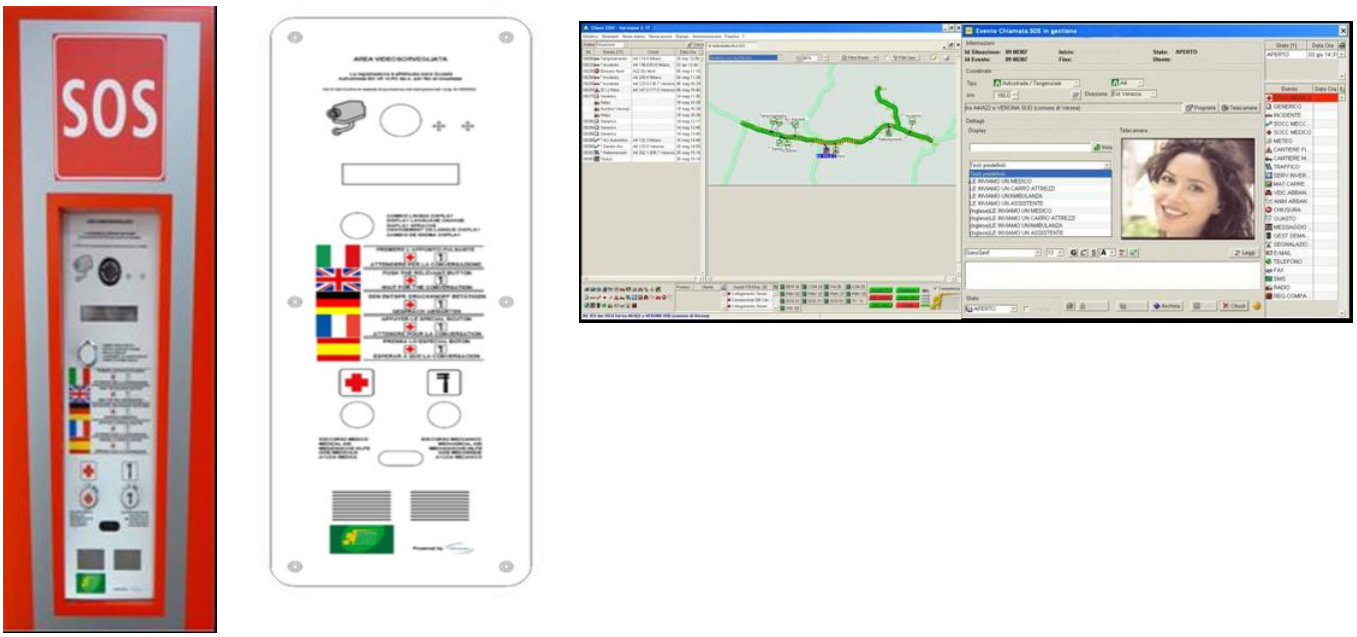


Figure 7: SOS Infrapoint and management software

3.1.1 Example Hungary

GENERAL INFORMATION

- Name of service/project: M0 Traffic Management System
- Name of operator/organisation: State Motorway Company
- Web link: www.autopalya.hu
- Contacts: Tomaschek.Tamas@autopalya.hu
- Other: /
- Applicable Deployment Guideline: Incident Warning TMS-DG05

GEOGRAPHICAL ASPECTS

- Country: Hungary
- Region of implementation: Central Hungary
- Networks concerned: Expressway M0
- Deployment indicators: Covered length (km) = 13 km

SERVICE DESCRIPTION

- Problem(s) addressed / Objectives (Relation to EW objectives. Background/motivation to the ITS application - basic question: WHY):
  - o Reduction of congestion
  - o Increase of safety
- ITS service description (Description of ITS application, example of systems used functionality and technologies used, users involved, location, context within wider ITS system, current status of the application. (maximum 50 words):

  The planned system for the management of M0 (Budapest Ring Road) uses video detection and loop detectors combined to eliminate the weaknesses of each detection methods.

  Visual detection points (10 places) are all equipped with two cameras (1 dome and 1 Automatic Incident Detection camera) to realise the automatic detection. The operators only have to deal with the alerts sent by the system. When they gain a warning they can use the dome cameras to verify the case.

  Loop detectors were deployed between each junction (3 cross-sections), and all major junction ramps are counted too.

  In addition to the traffic detection, there are some 2 weather stations, too.

  The system is capable to alert on queues, ghost drivers, fallen objects, by using VMS panels.
- Service requirements (Which type of requirements specifications have been used during the service implementation): Technical requirements
- Requirements specifications (If you have ticked any of the requirements above, can you provide information on how you have received or elicited the requirements, e.g. national recommendations, stakeholder sessions, etc.): National recommendations for the use of VMS panels, and recommendations for deployment of Intelligent Traffic Control and Information Systems

IMPLEMENTATION ASPECTS

- Duration (start, end): 10 2009 - 12 2009
- Impacts assessment / results (Description of impacts in terms of safety, travel efficiency, environmental impacts, security, traffic management…):

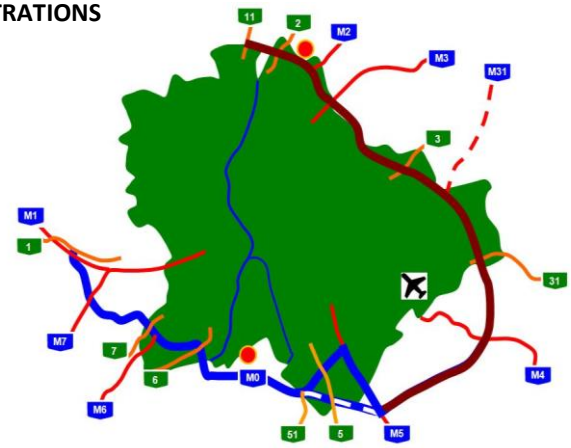
  The main goals of the pilot project:

- to reduce travel times by early warning on incidents
- to prevent secondary accidents
- are successfully achieved.

REFERENCES

- Documentation available on the project
  - Title: Impacts of the ITS Investments on Hungarian Motorways
  - 3rd EasyWay Annual Forum, Lisbon 2010
  - Contact: Tomaschek.Tamas@autopalya.hu
  - Language: English

ILLUSTRATIONS



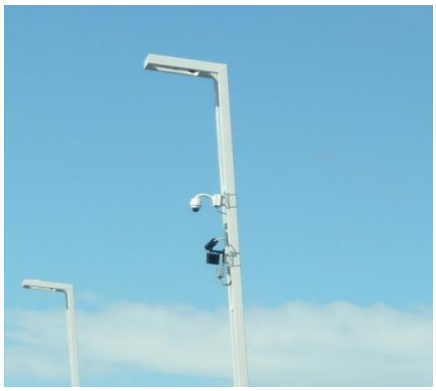


Figure 8: Hungarian network and traffic management systems

3.1.2 Example Denmark

GENERAL INFORMATION

- Name of service/project: Incident Management on Motoring 3
- Name of operator/organisation: Vejdirektoratet
- Web link: www.trafikken.dk
- Contacts: Lene Mårtensson, lemaa@vd.dk
- Other: /
- Applicable Deployment Guideline TMS DG08 Incident Management

GEOGRAPHICAL ASPECTS

- Country: Denmark
- Region of implementation: Copenhagen
- Networks concerned: Motorway
- Deployment indicators: 14 Number of kilometers

SERVICE DESCRIPTION

- Problem(s) addressed / Objectives (Relation to EW objectives. Background/motivation to the ITS application - basic question: WHY):
  - o Reduction of congestion
  - o Increase of safety
- ITS service description (Description of ITS application, example of systems used functionality and technologies used, users involved, location, context within wider ITS system, current status of the application. (maximum 50 words):

  On Motoring 3 around Copenhagen there is a motorway control system with following key applications:
  - o Traffic detector system
  - o Variable speed limits (via variable speed signs, mandatory)
  - o Real time traffic information provided by VMS, e.g. incident warnings
  - o Video surveillance
  - o Web applications

  The Motorway control system was originally implemented as part of a large construction work in connection with the extension of the motorway from 2 to 3 lanes. The control system is still in use after the opening of the wider motorway

  Incident management: Formal organisation with commonly agreed procedures among all actors involved. Incident response is 24/7.

  Roles of all partners and transport of rescue vehicles and flashing arrow trailers are clearly defined in the incident management plan
- Service requirements (Which type of requirements specifications have been used during the service implementation): Technical requirements
- Requirements specifications (If you have ticked any of the requirements above, can you provide information on how you have received or elicited the requirements, e.g. national recommendations, stakeholder sessions, etc.): The ITS system has been in operation since 2005 and was implemented before the Deployment Guideline 2010

IMPLEMENTATION ASPECTS

- Duration (start, end): 1/4/2011 -
- Lessons learnt / factor of success (Key lessons learnt in various aspects of the planning and implementation process; could be technical, institutional/organizational, legal, financial – basic questions: Was the implementation a success / Were the objectives met? Why? What could be done differently next time?):
  - Institutional/organisational: The incident management plan made in cooperation with all involved partners has been an important factor of success
- Impacts assessment / results (Description of impacts in terms of safety, travel efficiency, environmental impacts, security, traffic management…):

  The construction works did not lead to an increase in the number of traffic accidents taking place on the M3. This was one of the primary success criteria for the traffic management system and the incident management.

  The safety impact of the Motorway Control System has not been evaluated after the opening of the motorway.

REFERENCES

- Documentation available on the project
  - Title: Impacts of Traffic Management on Motorring 3, VIKING, 2007-04-03
  - Language: Danish - with English summary
  - EW/TEMPO evaluation

3.1.3 Example Spain

GENERAL INFORMATION

- Name of service/project: Rear incident detection system
- Name of operator/organisation: DGT
- Web link: www.dgt.es
- Contacts: Enrique Belda Esplugues
- Other: Albano Arnes, Vicente R. Tomás
- Applicable Deployment Guideline: TMS DG05 Incident Warning

GEOGRAPHICAL ASPECTS

- Country: Spain
- Region of implementation: Valencia
- Networks concerned: A-3
- Deployment indicators: 20 Number of kilometers

SERVICE DESCRIPTION

- Problem(s) addressed / Objectives (Relation to EW objectives. Background/motivation to the ITS application - basic question: WHY): Increase of safety
- ITS service description (Description of ITS application, example of systems used functionality and technologies used, users involved, location, context within wider ITS system, current status of the application. (maximum 50 words):

  An ITS system to warn and to prevent rear incident is installed in A-3 motorway. The system is located in a motorway mountain port where vehicles have significant speed differences. The system monitors the speed of vehicles circulating in the right lane and forecast rear incidents. The system uses CCTVs, loops and prims signals

IMPLEMENTATION ASPECTS

- Duration (start, end): 2004 - The system is currently working
- Lessons learnt / factor of success (Key lessons learnt in various aspects of the planning and implementation process; could be technical, institutional/organizational, legal, financial – basic questions: Was the implementation a success / Were the objectives met? Why? What could be done differently next time?):
  - Technical

  Incidents have decrease after the ITS system deployment. Speeds in the area are more homogenous. Response time for warning end user is fundamental.
- Impacts assessment / results (Description of impacts in terms of safety, travel efficiency, environmental impacts, security, traffic management…):

  Results are very positive. Rear incidents are decreased in the system coverage area

REFERENCES

- Documentation available on the project:
  - Title: An ITS for accident prevention
  - Contact: E. Belda. ebelda@dgt.es
  - Language: English

ILLUSTRATIONS

Figure 9: Image of the road network where the system is located

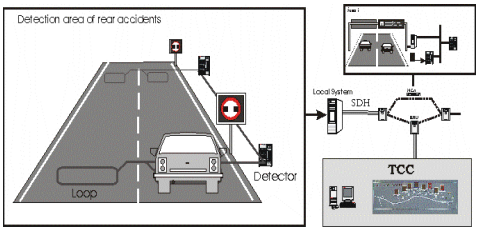


Figure 10: System architecture

3.2 Business Model

3.2.1 Stakeholders in Service Provision

The stakeholders usually involved in the provision of the incident warning and management service are:

1) Road authorities or concessionaire companies

The road authorities or concessionaire companies are responsible for the planning, development and operation of the systems for incident warning and management. For the implementation and later operation the increase and eventually optimization of traffic safety and traffic flow have to be the primary targets.

2) Law and public order Authorities or forces

On part of the responsible police departments, an on-site control of the systems should take place regularly in view of compliance of the displays and measures by the road users. These controls complement the protocol analyses of the switched states compiled by the operator. Only in case of proper acceptance of the systems it is possible to fully exploit the potential of incident warning and management service in terms of traffic safety and traffic flow.

Moreover the future implies or might imply an integration of infrastructure with the vehicles; therefore the other relevant stakeholders to be considered are the car constructors; the infrastructure-to-vehicle communication systems and the inter-vehicle communication ones require a common approach, at least at a general level, a standard in the telecommunication (ETSI) and related ITS supports.

The information in future might be repeated on board and therefore we see the integration of VMS, panels, networked roadside markers with dashboards; even the delay in communication, when transmitting inter-vehicle warning message and management measures with the help of infrastructure (when vehicles are lacking) is a relevant point; a safety and reliability level of communication is important as well.

3.2.2 Cost / Benefit Analysis

The C-B analysis implies an evaluation of the cost effectiveness of different alternatives in order to see whether the benefits outweigh the costs; within these lasts, reduction of accidents, saved time and other outcomes have to be quantified.

A specific costs and benefits analysis cannot be defined when a system or a service has already been implemented, but it should be made in advance of the decision about the deployment of the service or system, using earlier evaluation results. Anyway, given also the Directive 2008/96/CE - of the European Parliament and the Council on road infrastructure safety management, published in the Official Journal of the European Union, OJEU, on December 1st, 2008 – a specific working activity has to be carried out to quantify costs and benefits of ITS installations, also according to the point (7), article 7 second comma, last point of Annex 3. The Directive aims at the establishment of procedures to ensure a consistently high level of road safety throughout the trans-European road network.

A possible analysis concerning the safety viewpoint can be carried out referring to a period of some years. The safety benefits can be estimated by analysing injury accident records, so the "before" and "after" application period for calculating the number of accidents can be typically 3 years, but the analysis can be based on different time series.

However accident numbers are influenced by many variables so it is necessary to estimate the effects of changes due to these variables in order to distinguish them from the effects of introducing ITS. The variables that should be taken into account in the analysis are:

- Time trend
- Annual average daily traffic flow
- Length of the link/section
- Season (by quarter)
- Number of motorway lanes

- Road lighting
- Intensity of roadwork activity
- Effect of other operational systems

An analysis concerning the congestion relief benefits should be carried out, for example developing a relationship between the delay attributable to non-recurrent congestion and Annual Average Daily Traffic flow. A non-recurrent congestion is defined as that which is not due to the volume of traffic, but to unexpected events like incidents and road works.

At the same time, the number of injury accidents that occur during the periods when an incident warning is active can be calculated and it must be compared with the number of injury accidents that would have occurred if it had not been operated. This latter number is not known and can only be estimated.

4 Annex A: Compliance Checklist

4.1 Compliance checklist "**must**"

#	Requirement	Fulfilled?		If no – quote of insurmountable reasons
		Yes	No	
Functional requirements				
FR1	Secondary accident prevention (to prevent further accidents as a result of a first accident or other incidents): if VMS are available, measures **must** be taken to warn road users of incidents ahead (e.g. traffic jams, limited availability of the crossing section, accident, etc.).			
FR5	Traffic management: If ITS is available at the incident scene, traffic management measures **must** be taken at the start of the IM process e.g. dynamic lane closure, speed control, rerouting.			
FR6	Rescue: emergency (medical) assistance **must** be provided by IM responders, as defined in the safety measures protocol.			
Organisational requirements				
OR1	For the effective functioning of the IM process, all IM partners **must** cooperate not only during incidents but also in planning and evaluation. This ensures the continuity and enhanced the quality of the IM process.			
OR2	Protocol: a safety measures protocol **must** be prepared, defining common and agreed safety measures for IM responders at the incident site as well as agreement on roles and responsibilities of cooperating parties.			
Technical requirements				
TR1	The traffic control centre (TCC) -or person/body in charge- **must** monitor the functions and operational states of the equipments.			
TR3	In the case that road operators have to exchange data requiring interoperability between two or more different organizations, they **must** enable their system to use DATEX II.			

Common Look & Feel requirements				
CL&FR1	The road user must be aware of how to call for help. For IM there **must** be at least one of the following services available on the TEN-T Roads: o Mobile coverage (to make it possible to call 112) o Emergency Roadside Telephone (ERT) or SOS column/device o eCall (in future when it will be available in all vehicles)			
CL&FR4	If VMSs are available, warning signs **must** be used if possible.			
CL&FR9	On sections where incident warning and management systems are implemented, the road user **must** be able to provide their location. This could be achieved by e.g. road number, direction and distance marker post information, ERT			
Level of Service requirements				
None				

4.2 Compliance checklist "**should**"

#	Requirement	Fulfilled?		If no – quote of insurmountable reasons
		Yes	No	
Functional requirements				
FR2	Detection/Discovery: Measures **should** be taken to detect incidents as early as possible in order to initiate early warnings and incident management. Detection can be done through both technology and human forces.			
FR3	Verification: the identification of the nature, accurate location and impact of an incident (e.g. the number of cars/HGVs involved, number of victims, damage, and dangerous goods) **should** be communicated between IM partners.			
FR4	Clearance of the road: measures **should** be taken to enable IM responders to gain access to the incident. To enable restoration to normality the incident scene **should** be cleared, so that traffic flow can be restored.			
FR9	Salvage/Recovery: Measures **should** be taken to recover broken down vehicles. In case of HGVs or professional users, an estimation of the economic value of the load as opposed to the socioeconomic costs of the road closure may be made to determine the salvage approach.			
FR10	Repair of road damage: If an incident has caused damage to the road or roadside equipment which may influence the safety level of road users, measures **should** be taken to repair the damages and/or safeguard the area.			
FR11	Logging and monitoring reports **should** be produced, containing information about the nature, location and impact of the incident.			
Organisational requirements				
OR3	The IM partners **should** appoint one IM Coordinator, who has final responsibility on the scene. The IM Coordinator can vary between IM partners, depending on the type of incident.			

Technical requirements				
TR2	When handling an incident, TCC **should** avoid focussing completely on the incident. The TCC should continue to monitor the traffic flow on the whole network.			
Common look & feel requirements				
CL&FR2	VMS messages used for incident warning or traffic management **should** be harmonised. They provide information, for example about: accident ahead, debris/obstacles on the road, hazardous material on the carriageway, fog, wind, ice/snow.			
CL&FR3	In dangerous situations at least a danger warning **should** be used as a minimum			
CL&FR5	In order to guarantee the harmonization, a danger warning sign **should** be used in accordance with prevailing national road codes and where applicable be in line with the requirements of the EW-DG for Variable Message Signs Harmonization VMS-DG01.			
CL&FR8	If it isn't possible to use a well know pictogram, like those represented above, the display of signs/pictograms on VMS or other end-user devices **should** be in accordance with prevailing national road codes and where possible be in line with the requirements of the EW-DG for Variable Message Signs Harmonisation VMS-DG01 and VMS-DG02: • MS which ratified the 1968 Convention MUST respect the 1968 Convention and SHOULD consider the Consolidated Resolution on Road Signs and Signals (R.E.2); • MS which did sign but not ratify the 1968 Convention SHOULD follow the 1968 Convention and also consider the R.E.2.			
Level of Service requirements				
LOSR1	Given that pre-deployment surveys and evaluations provide the necessary evidence to proceed with deployment, the minimum and optimum LoS **should** respect the Level of Service to			

	Operating Environment mapping table. LoS/OE does not imply any obligation to deploy ITS services. However if services are deployed they **should** comply with the following table.			

4.3 Compliance checklist "**may**"

#	Requirement	Fulfilled?		If no – quote of insurmountable reasons
		Yes	No	
Functional requirements				
FR7	Information to road users: road users **may** be warned about the impact of the incident e.g. duration, diversion, road blockage, traffic management measures.			
FR8	Site investigation: investigation **may** be carried out on the cause of the incident.			
FR12	Evaluations and proposals for improvement **may** be analyzed and used to optimize the IM process.			
Organisational requirements				
None				
Technical requirements				
None				
Common look & feel requirements				
CL&F6	In addition, the type of incident **may** be clearly defined on the VMS (if the VMS is fitted with lines and alphanumeric characters)			
CL&FR7	If a single icon is not enough to ensure a driver's clear understanding, other danger warning signs **may** be used in accordance with prevailing national road codes and where applicable be in line with the requirements of the EW-DG for Variable Message Signs Harmonization VMS-DG01			
Level of Service requirements				
None				

5 Annex B: Bibliography

1. S. Bradner, (Network Working Group). Key words for use in RFCs to Indicate Requirement Levels. The Internet Engineering Task Force (IETF). [Online] March 1997. http://www.ietf.org/rfc/rfc2119.txt.

2. European Parliament and Council, Directive 2008/96/CE, Road infrastructure safety management, publ. in the Official Journal of the European Union, OJEU, on December 1st, 2008

3. Dalla Chiara B., Deflorio F. P., Diwan S., Assessing the effects of inter-vehicle communication systems on road safety, IET Intelligent Transport Systems, June 2009, IET Intelligent Transport Systems, 2009, Vol. 3, Iss. 2, pp. 225–235, doi: 10.1049/iet-its:2008.0059

4. Proctor S., Belcher M, Cook P., "Practical Road Safety Auditing", TMS Consultancy, publ. Thomas Telford, 2001, ISBN 0727729381

5. Highway Agency, M25 Controlled Motorways Summary Report, March 2007, Bristol SW060332. PR74/07

6. Highway Agency, Policy and Procedures for the use of Variable Message Signs by the Regional Control Centres, February 2007, PR55/07

7. Steve Tucker (Highways Agency), Ian Summersgill, John Fletcher, David Mustard (TRL), Evaluating the benefits of MIDAS automatic queue protection, Tec, October 2006

8. Highway Agency, Cost effectiveness of MIDAS, TRL Report 383, 1998, TRL Unpublished Report PR/T163/00, March 2001

9. CEDR, "Traffic Incident Management, European best practice", March 2011 (www.cedr.eu)

6 Annex C: Details

6.1 Common standards

Applicable national standards include for example:

- Road vertical signs - Variable message traffic signs - Part 1: Product standard
- Road vertical signs - Variable message traffic signs - Part 2: Initial type testing
- Road vertical signs - Variable message traffic signs - Part 3: Factory production control
- UNI/TR 11218:2007 [I-Italy], “Pannelli a messaggio variabile - Caratteristiche in funzione degli ambiti applicativi (Variable message signs - Characteristics related to the type of application); it is a technical report providing a guide for the application of UNI CEI EN 12966-1 in relation with the application field of VMS.
- UNI – CEI 70031 [I-Italy], "Telematica per il traffico ed il trasporto su strada - Norma quadro - Prospetto generale delle applicazioni, riferimenti ed indirizzi normativi (Telematics for traffic and road transport - Framework standard – General prospect of applications, references and standard guidelines)" and related Annex, UNI-CEI , Milan, July 1999; this is a general technical normative concerning almost all ITS.
- DIN EN 12966-1/A1, Draft standard , 2009-04 , Road vertical signs - Variable message traffic signs - Part 1: Product standard; German version prEN 12966-1/A1:2009
- XP P98-532-9 Norm [F, France], 2007-01-01, Road traffic signs - Catalogue of traffic sign decors - Part 9 : typology and dimensional characteristics of variables messages panels
- XP P98-573 Norm [F, France], 2008-10-01, Road traffic signs - mobile variable messages signs - General characteristics
- NF P99-341 Norm [F, France], 2001-06-01, Road information and control - Road control language - Controlling and checking of variable message signs.
- NF P99-341-1 Norm [F, France], 2008-02-01, Road Information and control - Road control language - Part 1 : controlling and Checking embedded variable message signs.
- OENORM EN 12899-1 Norm [O-Austria], 2008-01-01, Ortsfeste, vertikale Straßenverkehrszeichen - Teil 1: Verkehrszeichen, Fixed, vertical road traffic signs - Part 1: Fixed signs
- UNE-ENV 12694 Norm [E-Spanish], 2003-04-04, Public transport. Road vehicles. dimensional requirements for variable electronic external signs.

Other relevant documents:

- For equipping traffic control centres:
  - Technical bulletin for the equipment of traffic control centres and sub-centres (MARZ 99), edited by the federal highway research institute (BASt – D)
  - Technical specifications for local control stations (TLS) 2002, edited by the federal highway research institute (BASt-D)
- For evaluation of efficiency:
  - Recommendations on the efficiency evaluation and calculation of traffic control systems, edited by the research association for road and traffic engineering (FGSV), working group traffic management, issue 2007
- Other important documents are:

- Guidelines for variable message signs at federal trunk roads (RWVZ, D)
- Design Manual for Roads and Bridges (UK)
- Traffic Systems and Signing Plans Registry (UK)

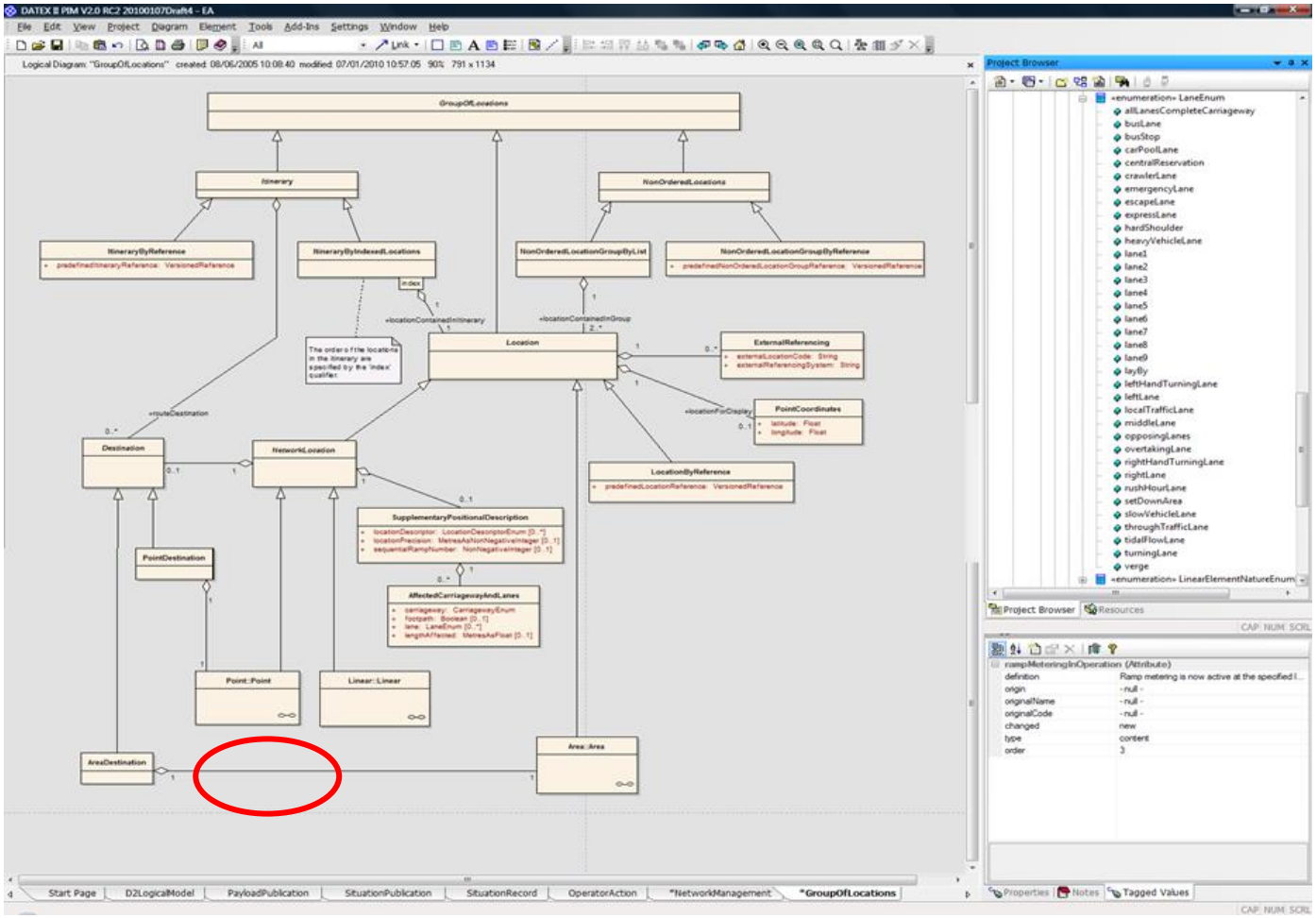
In future there is the necessity to define standards concerning all kind of networked road signals - including flashing lights, driveway or roadside markers, illuminated panels, wired delineators, curb systems, markers, channelizers - for showing hazardous stretches and the occurrence of primary accidents, installed along the motorway in large number, one close to the other.

These required standards could have an impact on the agreement of standard signs at national level with potential legal changes and costs linked to the implementation of a new or revised equipment.

6.2 Datex II profile

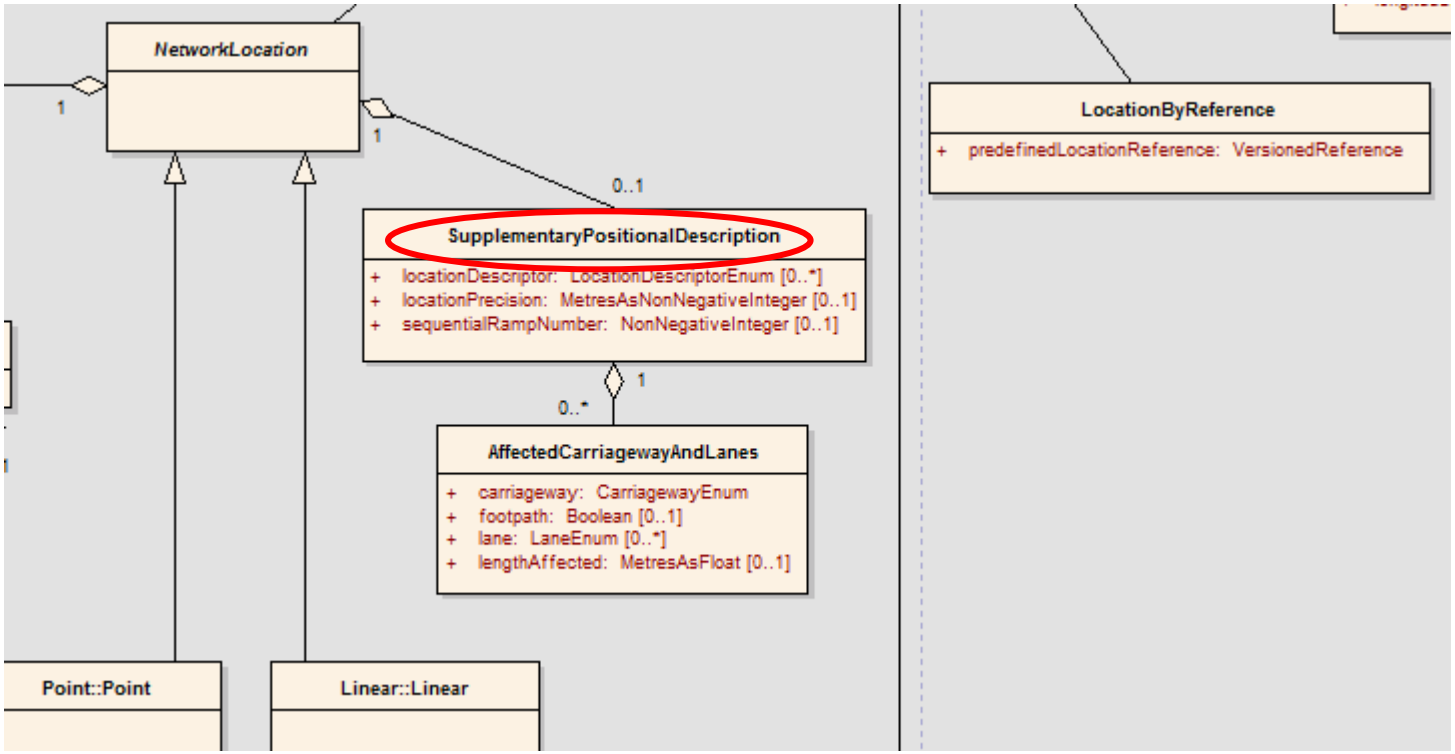
- Location:

  The DATEX II model offers various possibilities for describing location but for this service location referencing can be restricted to point locations. The SupplementaryPositionalDescription feature can be used to precise the length of the measure.



- Length:

Description about the length of the service has to be precised with the attribute lengthAffected.

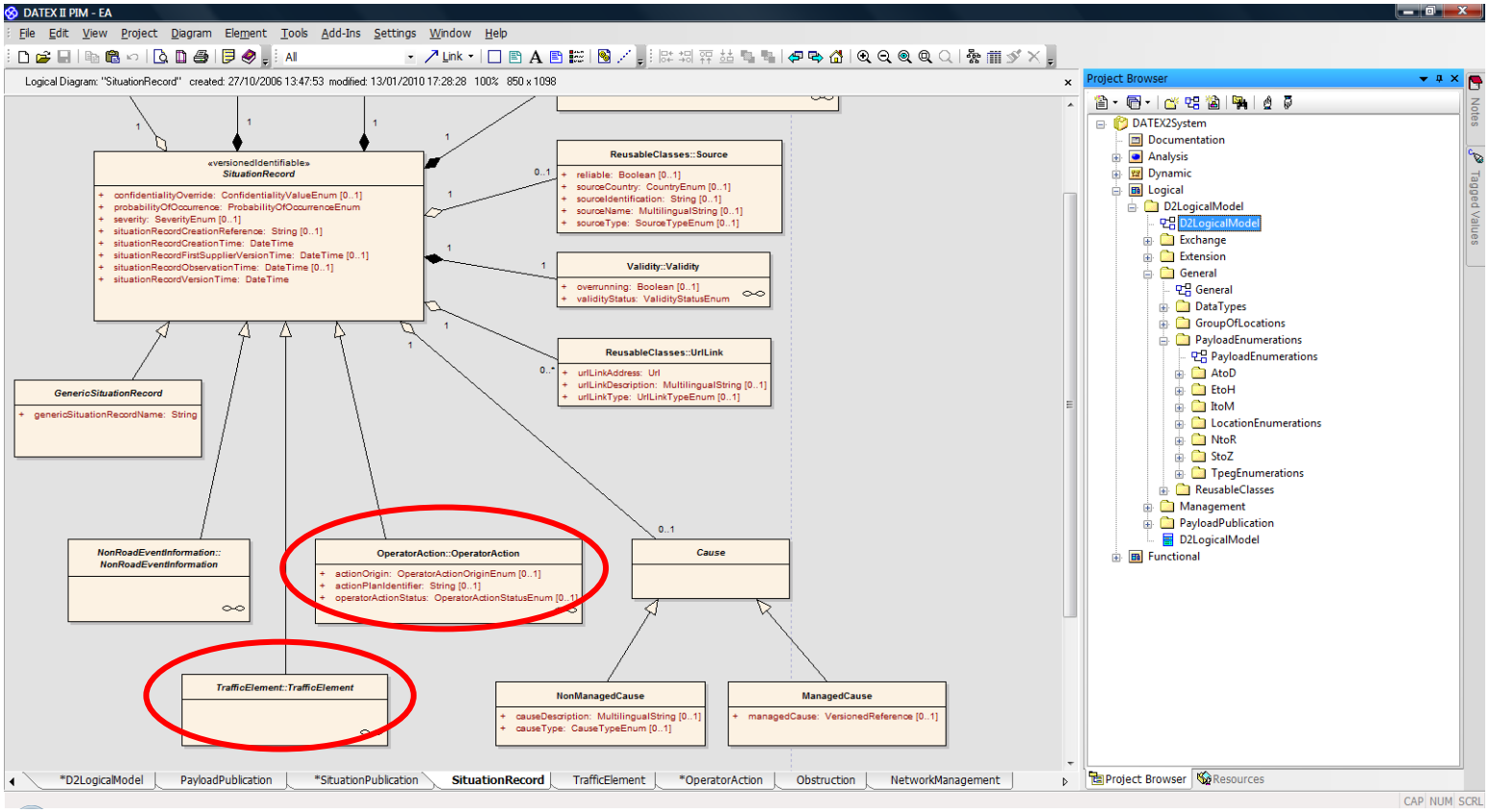


- Incident Warning or/and Management:

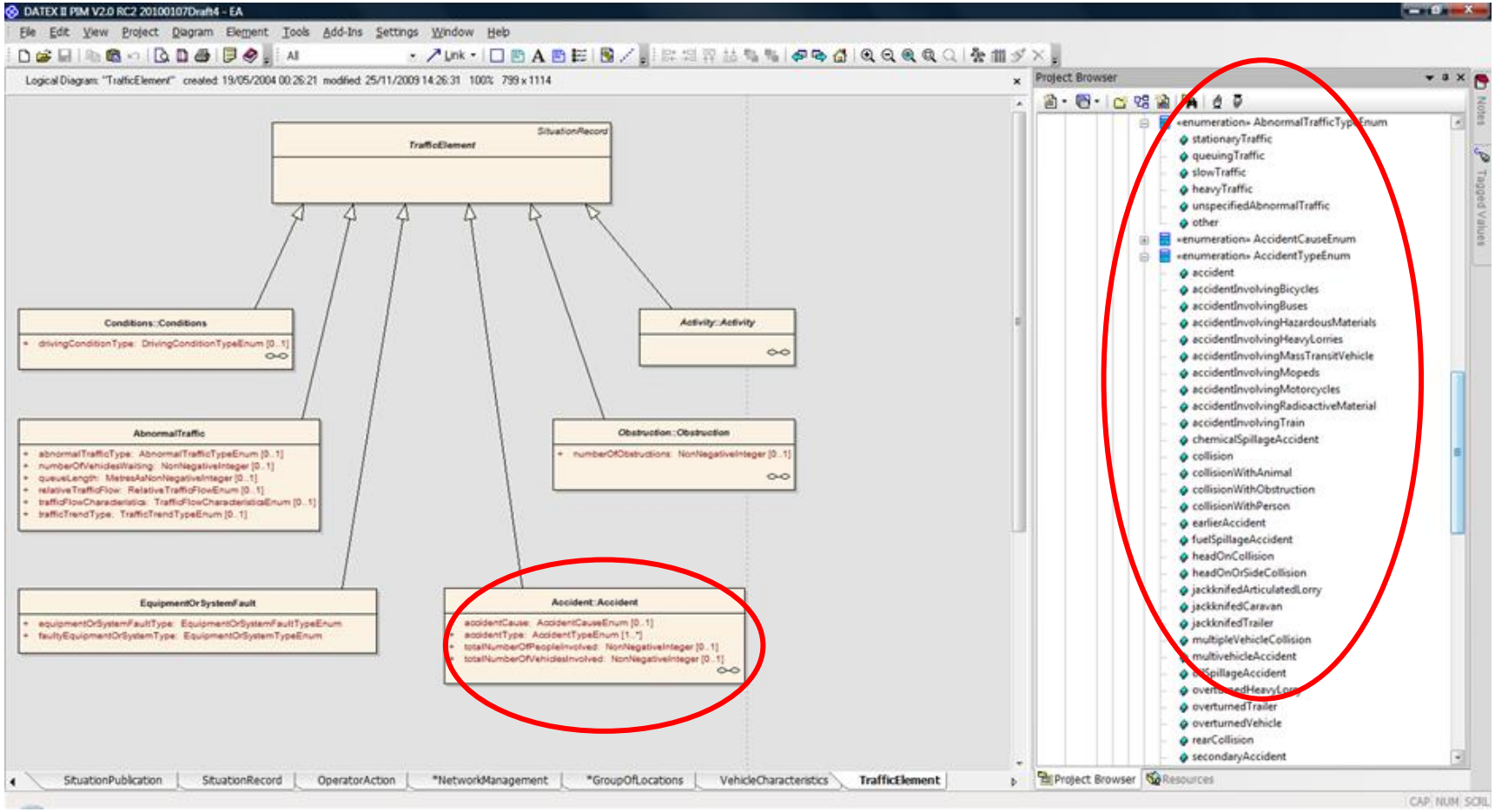
When incident occurs 2 type of actions related to the service have to be handled: first concerns the end users alert warning, the second deals with concrete actions and measures of road operators to be implemented.

Within the DATEX II models:

- o end users alert warning are described within TrafficElement class attached to SituationRecord
- o road operator actions are described in OperatorAction class attached to SituationRecord



- Incident Warning (dealt in TrafficElement class):



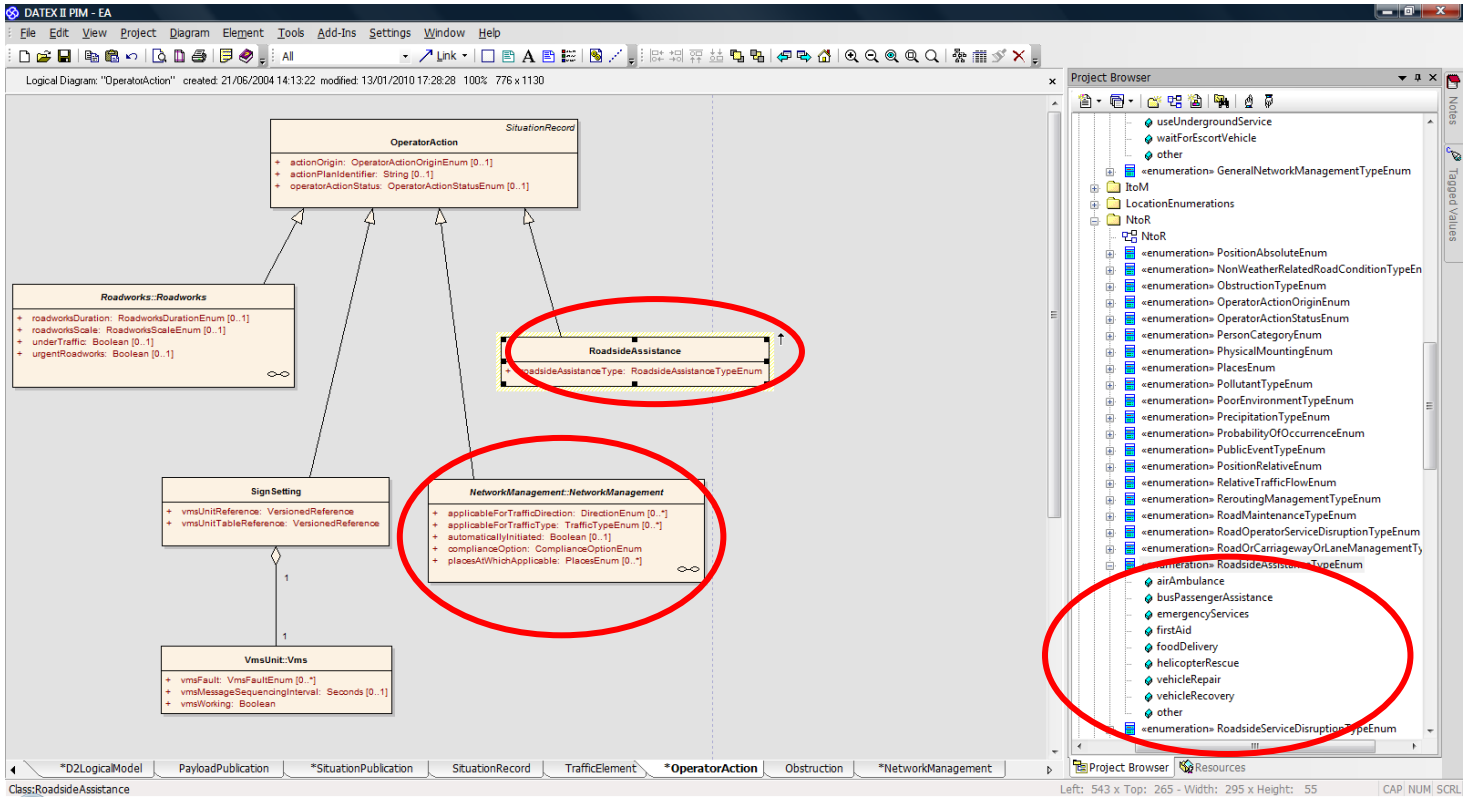
Within the TrafficElement class select the class corresponding to the incident which occurs, the following schema presents an example for an accident, within the Accident class select in the AccidentTypeEnum the information to be displayed.

The proposed modelling means that some incident Situations will contain multiple SituationRecords, e.g. the accident description and the operator actions taken. It would be helpful to define guidance on the management of such multiple-record situations. Alternatively, it might allow for modelling only the operator action, with only a nonManagedCause (e.g. of causeType “accident”).

- Incident Management (dealt in OperatorAction):

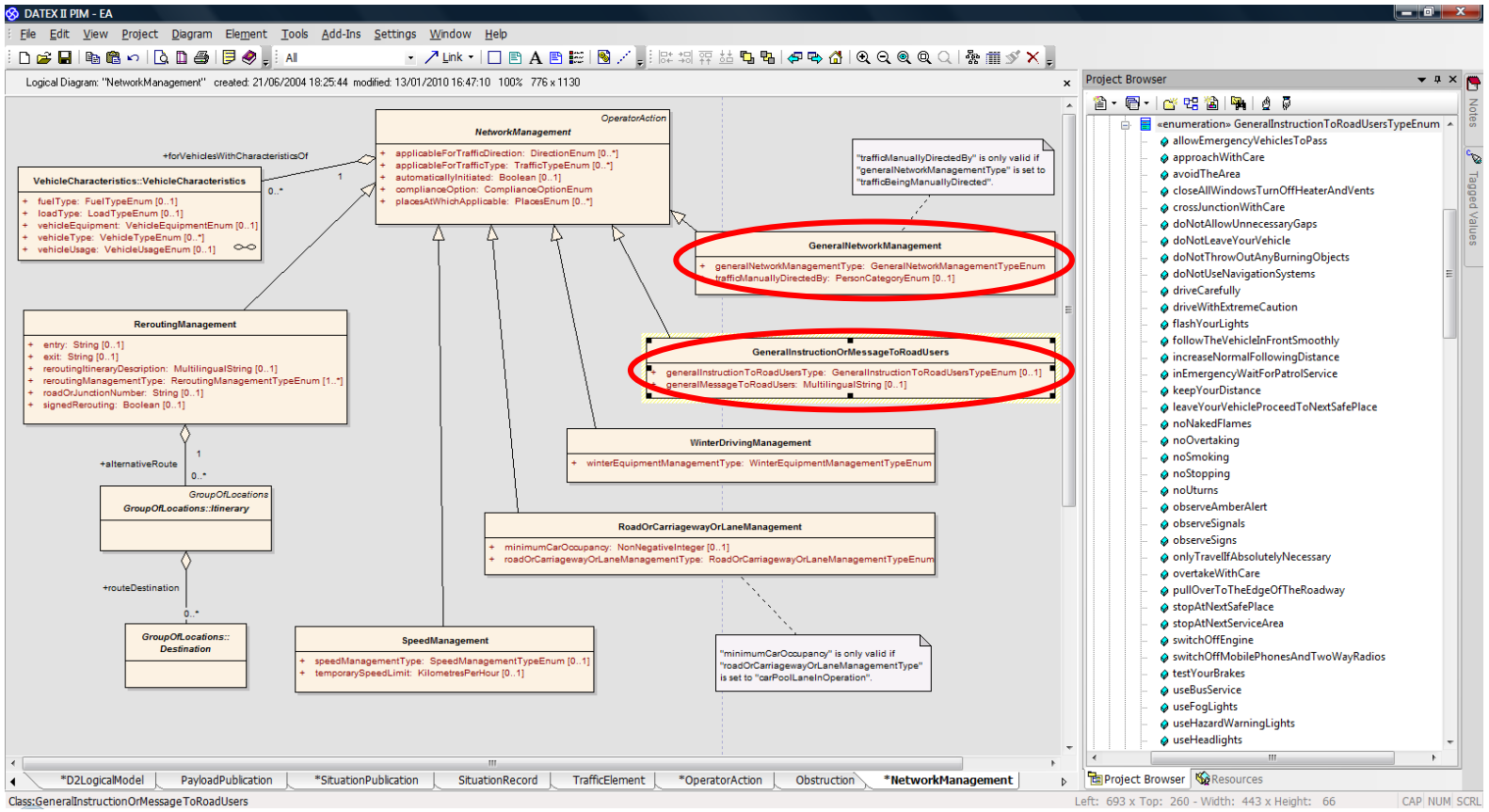
Two main classes are concerned for the description of the traffic managers actions in case of an incident:

- o RoadSideAssistance, select in the RoadsideAssistanceTypeEnum the relevant attribute
- o NetworkManagement, this class details the operators actions (see following schema)



- Network Management:

The networkManagement class regroups all class which corresponds to the possible actions taken by the road operator to face an incident, nevertheless the GeneralNetworkManagement class and GeneralInstructionOrMessageToRoadUsers regroups the main attributes to be disseminated to the end users.



The profile provided mentions the data modelling and formatting aspects of DATEX II, but there are also data exchange requirements/recommendations that should be defined and taken in to account (i.e. the protocols).