Reference Handbook for harmonized ITS Core Service Deployment in Europe

EU EIP
European ITS Platform

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Preface

The expectations placed on the existing European road transport infrastructure are increasing due to the growing mobility needs of the population on the one hand, and the rising volume of freight traffic on the other. At the same time, we intend to improve the quality of life of the European citizens by reducing emissions. We have agreed to make Europe climate-neutral by the year 2050 and to further reduce the number of road fatalities and injuries. In order to ensure security of supply, by maintaining supply chains, individual freedom of travel together with climate goals and traffic safety in the future, an efficient use of the existing road infrastructure through the use of new and innovative technologies is indispensable.

Intelligent Transport Systems (ITS) enable managing traffic flows and keeping users informed, thus making the best use of the infrastructure. Traffic and data flows are increasing within Europe, as well as cross-border traffic and the need for data exchange, making it all the more important to harmonise the technical and organisational framework conditions.

Within the framework of the European ITS Platform (EU EIP), co-financed by the European Commission, the ITS Deployment Guidelines, which were developed in previous projects (EasyWay, EIP+), were fundamentally revised to further harmonise the technical and organisational implementation of ITS. For example, due to the entry into force of the Delegated Regulations for the provision of: road safety relevant traffic information 886/2013, information services for safe and secure parking areas for trucks and commercial vehicle 885/2013, EU-wide real-time traffic information services 2015/962 and EU-wide multimodal travel information 2017/1926, a revision of the ITS Deployment Guidelines was necessary to maintain compliance with the regulations. In addition, new features and innovations have been introduced, in order to respond to recently arising topics, such as digitalisation of road transport:

— Bundling and streamlining concept of the Reference Handbook: The formerly 19 individual ITS Deployment Guideline documents have been combined into a single Reference Handbook, with the goal to eliminate repetitions and increase clarity.
— DATEX II Recommended Service Profiles: In close cooperation with the DATEX II Program Support Action, a Recommended Service Profile was created for each ITS Service. The Recommended Service Profiles are publicly available and provided free of charge. The ITS service descriptions refer to the corresponding profiles.
— References to C-ROADS specifications: On the basis of the Collaboration Note between EU EIP and C-ROADS, each ITS service was checked to see whether it could be supported or supplemented by Cooperative Intelligent Transport Systems (C-ITS) services. The ITS service description refer to the corresponding C-ROADS Use Cases.
— ITS Deployment References: Approximately 100 Deployment References from ITS implementations of the five Connecting Europe Facility (CEF) Corridors were collected, converted to a uniform format and listed in the annex to the Reference Handbook.
— Target Groups: To ensure that different interest groups can quickly obtain the relevant information from the Reference Handbook, the chapters that are of special interest for the defined interest groups (Strategic Bodies, Implementation Managers and Expert Engineers) have been marked accordingly with a relevant pictogram. For more information see chapter 1.4.
— Website: An accompanying website to the PDF/printed Reference Handbook has been developed.

The Reference Handbook was created by ITS experts and practitioners and refined in a commentary process by member states experts. The innovations introduced ensure that the content is comprehensive and up to date, as well as underpin its credibility and relevance. In addition, its significantly improved accessibility ensures that the various users can easily obtain the necessary information. The Reference Handbook constitutes an essential basis for a harmonised and cross-border implementation of ITS services. Thus, it is a powerful tool in the effort to master the challenges of the European transport infrastructure described at the beginning. It makes a significant contribution to maintain a competitive European economy and constitutes a major component on the road to a modern and climate neutral society.

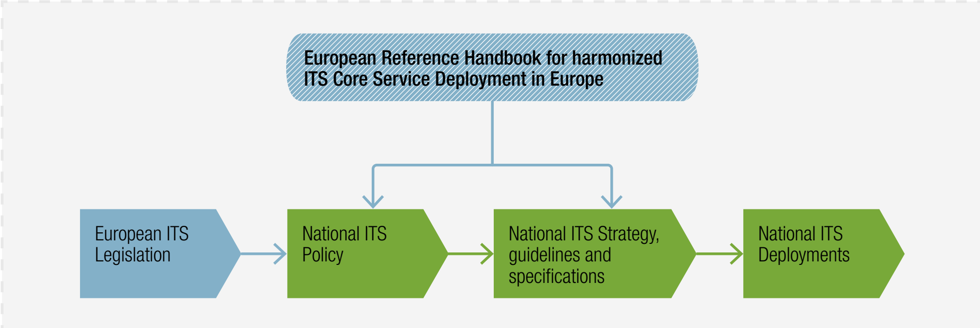
Executive Summary

Reference Handbook for ITS Core Service Deployment in Europe – Background & Scope

The *Reference Handbook for ITS Core Service Deployment in Europe* comprises a series of guidance and advice for use by road authorities and operators to support them in development of their strategic approach, design development, deployment, installation and operation of Intelligent Transport Systems and Services (ITS) and remain compliant with EU legislation.

The purpose of the guidance is to assist Member States in taking a broadly similar approach so wider European added value can be achieved, while at the same time delivering the needs of individual Member States, as outlined in Figure I.

Figure I: **Integration of the ITS Reference Handbook in national specifications**



The content of the handbook has been written by ITS practitioners and experts in the field of Traffic and Travel Information and Traffic Management systems from across Europe. The authors pay particular attention to the introduction of the Delegated Regulations issued under the European ITS Directive (DR (EU) 2013/885, 2013/886, 2015/962 and 2017/1926) and how these requirements are to be incorporated into ITS systems and services.

The traditional domains of road operators have now opened up to data and information exchange with actors outside their own area of responsibility. In response, the guidelines incorporate the results achieved by the European C-ITS platform C-ROADS, so handbook users can see how other data services and future C-ITS services with impact their schemes and operations. In addition, through the cooperation of EU EIP with DATEX II, Recommended DATEX II Service Profiles have been developed for the ITS Core Services included in the handbook.

The handbook contains information to facilitate the adoption of existing ITS Service specifications and best practice in four areas where European cooperation can bring added value. These areas are:

1. Functional and organisational interoperability with neighbouring ITS Service providers	**2.** Common Look & Feel to present ITS Core services to the end user
3. Accurate information provision and acquisition on national access points and C-ITS interfaces	**4.** European-wide accepted criteria of assessment for ITS Core services (e.g. Level of Quality)

The four target user groups for the guidelines comprise:

Road Operators	End Users
Service Providers	Member States

Overview of ITS Core Services explored in this Handbook

The handbook focuses on European ITS Core services under three ITS Service categories with 14 specific ITS Services in total. The table below presents the key focus areas of the handbook.

Traffic & Travel Information Services (TTIS) Overview	
TTIS Objective	*Provision of travel and traffic information, including safety-related & real-time traffic Information to the road user, to improve the safety and the efficiency of the network supporting current traffic management activities and traffic management plans.*
TTIS-01 Forecast and Real-time Event Information	Provision of information about expected and unexpected events to road users on identified road segments of the network.
TTIS-02 Traffic Condition and Travel Time Information	Provision of information on the traffic conditions (Level of Service) and travel times on identified road segments of the network.
TTIS-03 Speed Limit Information	Provision of speed limit information to ensure that the driver always and everywhere knows what the speed limit in force is.
TTIS-04 Road Weather Information	Provision of information on conditions of the road surface, visibility conditions and infrastructure specific information of the network.
TTIS-05 Multimodal Travel Information	Comparative information of different modes/means of transport and/or the combination of different modes/means of transport within the same route.
Traffic Management Services (TMS) Overview	
TMS Objective	*Influence of traffic through a bundle of measures in order to coordinate traffic demand to the existing traffic system supply to guarantee traffic safety at the highest possible level, to increase the efficiency of the network to the maximum possible and to reduce traffic-related environmental impacts as far as possible.*
TMS-01 Dynamic Lane Management	Enablement of a temporally modifiable allocation of lanes by means of traffic guidance panels, permanent light signals, multiple-faced signs, LED road markers, closing and directing installations, etc.
TMS-02 Variable Speed Limits	Display of speed limits, advisory speed (recommended) or compulsory minimum speed, to guide drivers to travel at a speed suitable to the prevailing traffic, road or weather conditions.
TMS-03 Ramp Metering	Management of traffic at motorway junctions on a temporary basis usually during times of peak flow.
TMS-04 Hard Shoulder Running	Enablement of a dynamic temporary use of hard shoulders at road sections, including at junctions with the aim to increase road capacity when necessary.
TMS-05 HGV Overtaking Ban	Enablement of the channelling of heavy goods vehicles onto a single lane (slow lane).
TMS-06 Incident Warning and Management	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.
TMS-07 Traffic Management for Corridors and Networks	Application of Traffic Management Plans for the management of the European network and corridors including multi-modal capacities to allow for a more efficient use of the road network in Europe.

Freight & Logistic Services (F&LS) Overview	
F&LS Objective	*Enablement of a more efficient transfer of products from origin to destination using a supply chain network consisting of road, rail, ai, and waterways.*
F&LS-01 Intelligent and Secure Truck parking	Provision of information on the truck parking situation on the European networks and access roads to manage the parking space, support the observation of rest and driving periods for drivers, reduce dangerous parking and improve safety and security.
F&LS-02 Abnormal Goods Transport Regulations	Provision of country-specific information on the vehicle regulations and permit application procedures, contact persons, and guidelines for completing application forms for abnormal transports.

Overview of Handbook Structure

The Handbook is designed to facilitate quick assimilation. Through necessity, it incorporates a wealth of information. Therefore, in Section 1, the guidelines incorporate guidance to its reading, and a description of the overarching conceptual approach to describing each of the three ITS Services and 14 specific ITS Services highlighted above. In Section 2 they are explored separately following a standard structure. This structure is presented in Figure II below.

Figure II: **The common ITS service description standard**

ITS-Service deployment guidelines description structure

Per set of TTI-, TM & F&L services: Introductory

ITS service at a glance

ITS service profile*

- General ITS service description
- What is the vision?
- What is the mission?
- Distinctiveness to other ITS-Services

Harmonisation requirements and advice

- Functional requirements and advice
- Interface requirements
- Common look&feel requirements and advice
- ICT requirements and advice
- Required standards and specifications
- Level of (quality &**) service definition

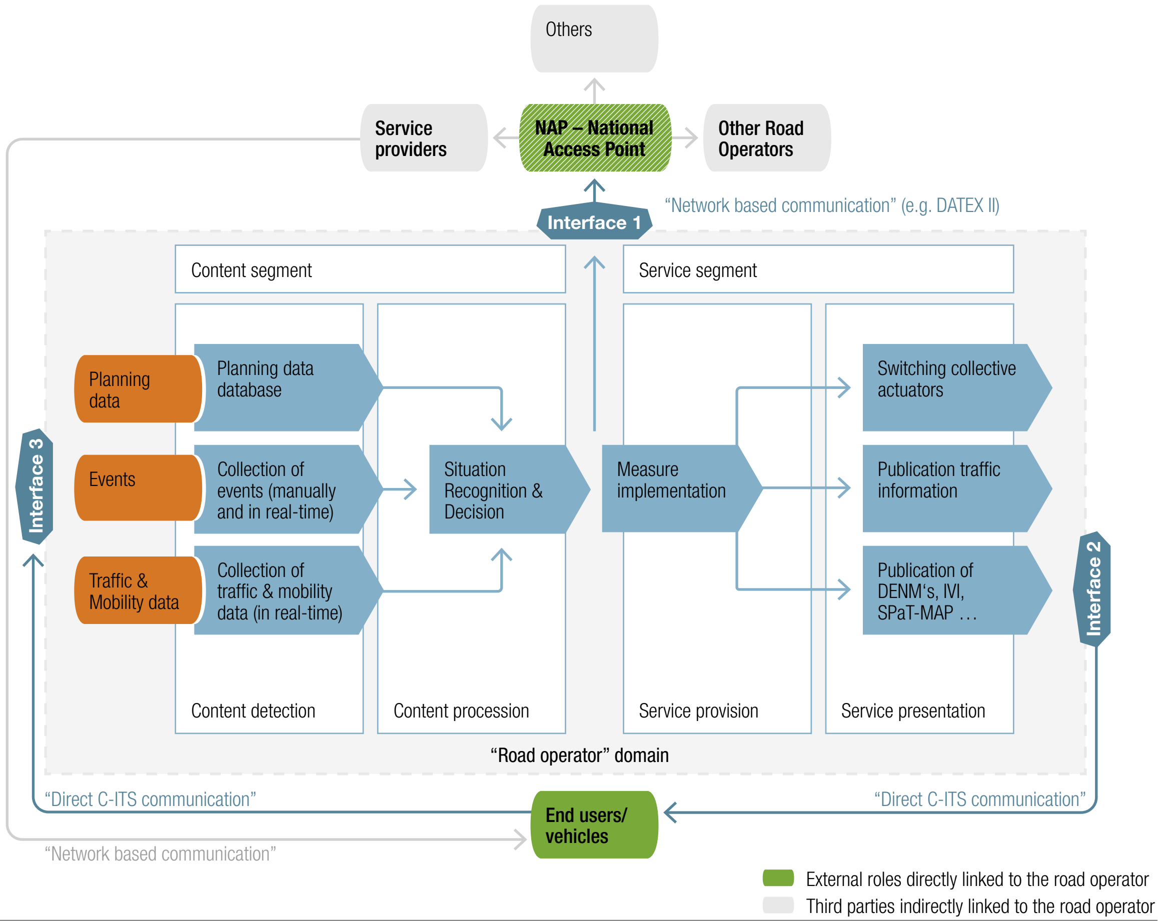
* only for TM and F&L services ** only for TTI and F&L services

Annexes: A: Deployment References | B: Compliance Checklists | C: Operating environment classification

The introduction to each of the three services provides decision makers with general and strategic information common to TTI, TM and F&L services. The sections on Service at a Glance and ITS Service Profile describe what is achieved by the service, its profile in relation to other services and what type of benefits are expected.

Information and advice are given on harmonisation requirements. This extends to the requirements for data sharing of each ITS Service. This is based on the generic data sharing structure presented in Figure III.

Figure III: **Data sharing architecture (Road operator view)**



Finally, three Annexes are incorporated to complement the handbook.

— **Annex A** provides a collection of references to existing deployments.
— **Annex B** lists mandatory features required for a harmonized ITS Core service deployment in form of a table named 'compliance checklist'.
— **Annex C** provides an explanation of the concept of the Operating Environments.

These Annexes are designed to provide examples of real-life deployments, along with further background information which will help in meeting the objectives of the reference handbook, which is to facilitate a European harmonised approach to the deployment of ITS systems and services.

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List of Abbreviations

Abbreviation	Description
ANPR	Automatic Number-Plate Recognition
CCAM	Cooperative Connected and Automated Mobility
CBA	Cost Benefit Analysis
CEDR	Conference of European Directors of Roads (www.cedr.eu)
CEF	Connecting Europe Facility
C-ITS	Cooperative Intelligent Transport System
C-ROADS	The C-Roads Platform is a joint initiative of European Member States and road operators for testing and implementing C-ITS services in light of cross-border harmonisation and interoperability. (https://www.c-roads.eu/platform.html)
ERA	ERA - Emergency Refuge Area (safe haven)
ERT	Emergency Road Telephone
ETSI	European Standards Organisation (www.etsi.org)
F&L	Freight and Logistics
F&LS	Freight and Logistics Services
FM	Frequency Modulation (FM broadcast band)
GIS	Geographic Information Systems
HGV	Heavy Goods Vehicle
Inter-modal	A transport system that allows at least two different modes, and/or means of transport, to be used in an integrated manner (in combination) in a door-to-door transport chain. This necessarily involves transferring from one mode (or means) of transport to another. This usually takes place at modal interchanges. The development of a seamless web of integrated transport chains linking road, rail and waterways (and/or also linking different means of transport) leads to improved flexibility, quality, and cost effectiveness.
ICT	Information and Communication Technology
ISO	International Organization for Standardization (http://www.iso.org/)
ITS	Intelligent Transport System
ITS Core Service	The ITS Core Service is an ITS Service as described with its core features in this Reference Handbook. In distinction to this, an ITS Service is a service that is related to an ITS Core Service in terms of its purpose and characteristics, but which may differ in its characteristics or may be equipped with additional characteristics.
LoQ	Level of Quality
LoS	Level of Service (Traffic condition)
LTE	Long Term Evolution (fourth generation mobile radio standard)
M&D	Monitoring and Dissemination
MDM	Mobility Data Marketplace
Multimodal	A transport system that offers at least two different modes and/or means of transport to be used in a parallel manner in a door-to-door transport. The policy principle is not to stick to one single mode/means of transport information but also offering alternative means of travel.
NAP	National Access Point
OBU	On Board Unit (ISO 17438-4:2019: Vehicle ITS Station)
OE	Operating Environment
OEM	Original Equipment Manufacturer (Vehicle manufacturer)
POI	Points Of Interest
RDS-TMC	Radio Data System Traffic Message Channel

RSU	Road Side Station (ISO 17438-4:2019: Roadside ITS Station)
RTTI	Real Time Traffic Information
TEN-T	Trans European Network - Transport
TTI	Traffic and Travel Information
TTIS	Traffic and Travel Information Services
TISA	Traveller Information Services Association (http://www.tisa.org/)
TM	Traffic Management
TMS	Traffic Management Services
TMC	Traffic Management Centre
TPEG	Transport Protocol Experts Group (data protocol suite for traffic and travel related information)
V2X	Vehicle to Everything
VMS	Variable Message Sign

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European ITS Service Deployment Reference Handbook

1 European ITS Service Deployment Reference Handbook

1.1 Significance and background of the Handbook

Purpose and aim

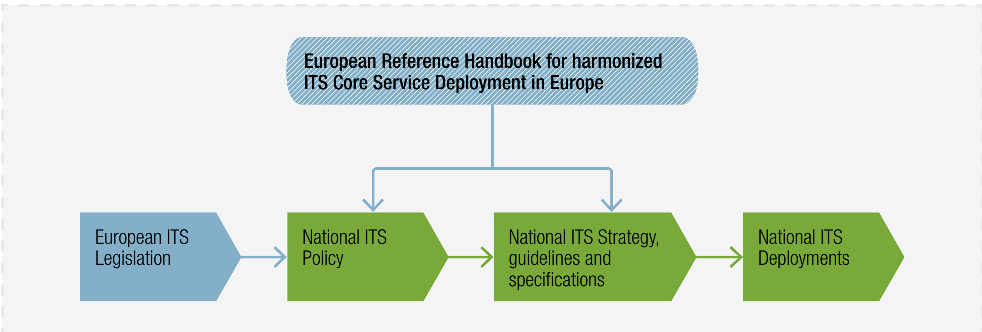
This handbook comprises a series of guidance and advice for use by road authorities and operators to support them in development of their strategic approach, design development, deployment, installation and operation of Intelligent Transport Systems and Services (ITS) and remain compliant with EU legislation.

The purpose of these guidance is to assist Member States in taking a broadly similar approach so wider European added value can be achieved, whilst at the same delivering the needs of individual Member States.

On the one hand, the EU Delegate Regulations - published in 2013 - 2019 - and the Guidelines for the practical implementation and use of ITS services - adopted by 17 Member States as early as 2012 - have emerged at very different times. On the other hand, their focus and objectives are very different, the authors were particularly keen to use this handbook to build a bridge between the more strategic Delegate Regulations and the functional, organisational and technical Deployment Guidelines.

Against this background, Member States are recommended to translate the handbook into their national language. So all persons involved in the implementation of ITS services - each at his or her own level - can not only benefit from the important requirements laid down in the handbook, but can also be sure that each national ITS deployment will comply with the requirements of the EU delegated regulations for ITS.

Figure 1: **Integration of the ITS Reference Handbook in national specifications**



Background

There is incontrovertible evidence from European nations and other parts of the world, that use of mature ITS, and more innovative systems now exemplified by C-ITS can make a significant contribution to improving transport efficiency, improving safety, and reducing negative impacts on the environment. A comprehensive compilation of the benefits of ITS implementations from the CEF-ITS corridors is presented in the publication "Digitalisation of road transport in Europe[1]". The Evaluation Toolkit, developed by EU EIP Evaluation (Activity 5), presents customised results on impact and benefits based on criteria selected by the user[2]. ITS help achieve these outcomes through providing deep understanding of the efficiency of the network at any point in time, making traffic management interventions when necessary, and communicating information to the road user and other stakeholders including neighbouring traffic management centres and service providers.

These benefits can be monetised, and Cost Benefit Analyses are attractive to road operators, Members States and the European Union, all of whom have common key objectives to improve transport provision to support economic growth, increase public safety and reduce short- and long-term environmental impact.

As a consequence, Member States have been extending the provision of ITS through wider deployment ITS Traffic Information Services such as Safety Related Traffic Information, Real Time Traffic Information, Multimodal Travel Information and Intelligent Truck Parking together with supporting infrastructure. Part of this infrastructure are traffic monitoring and sensing systems, as well as advanced traffic management systems.

At a European level, extending deployment and adopting a largely common approach in provision of ITS services derives wider benefits to trans-national users and assists in building a common European Transport Area. This is to the extent that the European ITS Action Plan, the ITS Directive (2010/40/EU) published in August 2010, and subsequent Delegated Regulations provides the legal basis and a framework for each nation to accelerate and implement harmonised and interoperable ITS systems and services.

This reference handbook assists in providing the reader with the necessary background and information needed to understand how core ITS Traffic and Travel Information and Traffic Management systems and services can be implemented in each Member State whilst supporting the requirements of the Directive and Delegated Regulations. In particular, it provides advice that will achieve added value of European harmonisation and interoperability. Moreover it describes data communication interfaces which will assist in building a digital layer for traffic and transport across Europe.

Overall this handbook provides a bridge between legislation and policy, and the needs of actors responsible for implementing ITS systems and services on the road network.

Note: This handbook draws from the perspective and expertise of road operators and focuses on ITS-Core services for road transport and inter-urban road networks. Urban networks as well as the upcoming discussion about automated driving are not in the scope of the current version of the handbook.

1 www.its-platform.eu/digitalisation-book
2 https://www.its-platform.eu/evaluation-toolkit

1.2 References to European background activities

1.2.1 Preliminary remark

The content of this handbook has been written by ITS practitioners and experts in the field of Traffic and Travel Information and Traffic Management systems from across Europe, working for Road an Transport Authorities and Road Operators in cooperation with the European Commission. The content had originally been drafted and adopted by Member States in 2012 as separate deployment guidelines, with an update in 2015 under the EasyWay and EU-EIP programmes. The current handbook is now published as a major revision to reflect changing requirements in a time of radical technological change.

The authors of this handbook had to pay particular attention to the introduction of the Delegated Regulations issued under the European ITS Directive (see 1.2.2). Furthermore, the emerging roll-out of C-ITS services created the need to incorporate the results achieved by the European C-ITS platform C-ROADS. The traditional domains of road operators have now opened up to data and information exchange with actors outside their own area of responsibility through various communication channels.

This cooperation adds significant value to the ITS services they operate, which is described in more detail in the following chapters 1.2.2 to 1.2.6. The technical reference, i.e. how the data and information exchange is technically implemented using European standards and specifications now available, is described in a general way in chapter 2, and partly in 3.1, 4.1 and 5.1 and specifically for each ITS service in the chapters “Harmonization requirements and advice”.

1.2.2 The European Delegated Regulations on Traffic and Travel Information Provision

Background

Having regard to Directive 2010/40/EU of the European Parliament and of the Council of 7 July 2010 on the framework for the deployment of Intelligent Transport Systems in the field of road transport and for interfaces with other modes of transport the European Commission adopted in 2013 the first two Delegated Regulations on the provision of information services utilizing so-called National Access Points (NAPs, more information see 1.2.4):

- **(EU) 885/2013**: the provision of information services for safe and secure parking places for trucks and commercial vehicles and
- **(EU) 886/2013**: the provision, where possible, of road safety-related minimum universal traffic information free of charge to users.

Two additional Delegated Regulations were adopted in 2015 and 2017 respectively:

- **(EU) 2015/962**: the provision of EU-wide real-time traffic information services and
- **(EU) 2017/1926**: the provision of EU-wide multimodal travel information services.

These delegated regulations can be found on the following links:

- the provision of information services for safe and secure parking places for trucks and commercial vehicles,
- the provision of road safety-related minimum universal traffic information free of charge to users,
- the provision of EU-wide real-time traffic information services and
- the provision of EU-wide multimodal travel information services.

Information to provide

The data and information listed in each delegate regulation, which - if available in digital form - entails an obligation to be made accessible in each Member State through its national access point, are presented in the following tables

Table 1: **(EU) 885/2013 (ITP) - Classification of data provision**

(EU)2013/885: The provision of information services for safe and secure parking places for trucks and commercial vehicles		
Static data related to the parking areas, including (where applicable)	**Information on safety and equipment of the parking area**	**Dynamic data**
Identification information of parking area (name and address of the truck parking area (limited to 200 characters))	Description of security, safety and service equipment of the parking including national classification if one is applied (500 characters)	Availability of parking places including whether a parking is: full, closed or number of free places which are available.
Location information of the entry point in the parking area (latitude/longitude) (20 + 20 characters)	Number of parking places for refrigerated goods vehicles (numerical 4 digits)	
Primary road identifier 1/direction (20 characters/20 characters), and Primary road identifier 2/direction (20 characters/20 characters) if same parking accessible from two different roads	Information on specific equipment or services for specific goods vehicles and other (300 characters)	
If needed, the indication of the Exit to be taken (limited to 100 characters)/Distance from primary road (integer 3) km or miles	Contact information of the parking operator: · Name and surname (up to 100 characters) · Telephone number (up to 20 characters) · E-mail address (up to 50 characters) · Consent of the operator to make his contact information public (Yes/No)	
Total number of free parking places for trucks (integer 3)		
Price and currency of parking places (300 characters)		

↳ **Editor's note:** For all links provided in the handbook (shown in blue, underlined), the relevant web addresses are provided in the section "List of web links" at the end of this handbook (see page 361).

Table 2: **(EU) 886/2013 (SRTI) - Classification of data provision**

(EU) 2013/886 (SRTI): The provision, where possible, of road safety-related minimum universal traffic information free of charge to users							
List of road safety-related events or conditions							
(a) temporary slippery road	(b) animal, people, obstacles, debris on the road	(c) unprotected accident area	(d) short-term road works	(e) reduced visibility	(f) wrong-way driver	(g) unmanaged blockage of a road	(h) exceptional weather conditions.
Information content							
(a) location of the event or the condition		(b) the category of event or condition as referred to in Article 3 and, where appropriate, short description of it			(c) driving behaviour advice, where appropriate.		

Table 3: **(EU) 2015/962 (RTTI) - Classification of data provision**

(EU) 2015/962 (RTTI) The provision of EU-wide real-time traffic information services	
Real-Time Traffic Information	**The types of the traffic data include in particular:**
(a) road closures	(a) traffic volume
(b) lane closures	(b) speed
(c) bridge closures	(c) location and length of traffic queues
(d) overtaking bans on heavy goods vehicles	(d) travel times
(e) roadworks	(e) waiting time at border crossings to non-EU Member States
(f) accidents and incidents	
(g) dynamic speed limits	
(h) direction of travel on reversible lanes	
(i) poor road conditions	
(j) temporary traffic management measures	
(k) variable road user charges and available payment methods	
(l) availability of parking places	
(m) availability of delivery areas	
(n) cost of parking	
(o) availability of charging points for electric vehicles	
(p) weather conditions affecting road surface and visibility	
Note: short-term data need not to be included in digital map updates as they shall not be considered as changes of a permanent nature.	

Table 4: **(EU) 2017/1926 (MMTI) - Classification of information provision**

(EU) 2017/1926 (MMTI) The provision of EU - wide multimodal travel information services		
Types of the dynamic travel and traffic data		
Level of Service 1	**Level of Service 2**	**Level of Service 3**
Passing times, trip plans and auxiliary information:	(a) Passing times, trip plans and auxiliary information (all modes):	Trip plans:
(i) Disruptions (all modes) (ii) Real-time status information — delays, cancellations, guaranteed connections monitoring (all modes) (iii) Status of access node features (including dynamic platform information, operational lifts/escalators, closed entrances and exit locations - all scheduled modes)	(i) Estimated departure and arrival times of services (ii) Current road link travel times (iii) Cycling network closures/diversions	Future predicted road link travel times
	(b) Information service	
	Availability of publicly accessible charging stations for electric vehicles and refuelling points for CNG/LNG, hydrogen, petrol- and diesel-powered vehicles	
	(c) Availability check	
	(i) Car-sharing availability, bike sharing availability (ii) Car parking spaces available (on and off-street), parking tariffs, road toll tariffs	

Types of the static travel and traffic data		
Level of Service 1	**Level of Service 2**	**Level of Service 3**
Location search (origin/destination): (i) Address identifiers (building number, street name, postcode) (ii) Topographic places (city, town, village, suburb, administrative unit) (iii) Points of interest (related to transport information) to which people may wish to travel Trip plans: (i) Operational Calendar, mapping day types to calendar dates Location search (access nodes): (i) Identified access nodes (all scheduled modes) (ii) Geometry/map layout structure of access nodes (all scheduled modes) Trip plan computation — scheduled modes transport: (i) Connection links where interchanges may be made, default transfer times between modes at interchanges (ii) Network topology and routes/lines (topology) (iii) Transport operators (iv) Timetables (v) Planned interchanges between guaranteed scheduled services (vi) Hours of operation (vii) Stop facilities access nodes (including platform information, help desks/ information points, ticket booths, lifts/ stairs, entrances and exit locations) (viii) Vehicles (low floor; wheelchair accessible.) (ix) Accessibility of access nodes, and paths within an interchange (such as existence of lifts, escalators) (x) Existence of assistance services (such as existence of on-site assistance) Trip plan computation — road transport (for personal modes): (i) Road network (ii) Cycle network (segregated cycle lanes, on-road shared with vehicles, on-path shared with pedestrians) (iii) Pedestrian network and accessibility facilities	Location search (demand-responsive modes): (i) Park & Ride stops (ii) Bike sharing stations (iii) Car-sharing stations (iv) Publicly accessible refuelling stations for petrol, diesel, CNG/LNG, hydrogen powered vehicles, charging stations for electric vehicles (v) Secure bike parking (such as locked bike garages) Information service: (i) Where and how to buy tickets for scheduled modes, demand responsive modes and car parking (all scheduled modes and demand-responsive incl. retail channels, fulfilment methods, payment methods) Trip plans, auxiliary information, availability check: (i) Basic common standard fares (all scheduled modes): - Fare network data (fare zones/stops and fare stages) - Standard fare structures (point to point including daily and weekly fares, zonal fares, flat fares) (ii) Vehicle facilities such as classes of carriage, on-board Wi-Fi	Detailed common standard and special fare query (all scheduled modes): (i) Passenger classes (classes of user such as adult, child, student, veteran, impaired access and qualifying conditions and classes of travel such as 1st, 2nd.) (ii) Common fare products (access rights such as zone/point-to-point including daily and weekly tickets/single/return, eligibility of access, basic usage conditions such as validity period/operator/time of travel/ interchanging, standard point to point fares prices for different point to point pairs including daily and weekly fares/zonal fare prices/flat fare prices) (iii) Special Fare Products: offers with additional special conditions such as promotional fares, group fares, season passes, aggregated products combining different products and add on products such as parking and travel, minimum stay (iv) Basic commercial conditions such as refunding/replacing/exchanging/ transferring and basic booking conditions such as purchase windows, validity periods, routing restrictions zonal sequence fares, minimum stay. Information service (all modes): (i) How to pay tolls (incl. retail channels, fulfilment methods, payment methods) (ii) How to book car sharing, taxis, cycle hire etc. (incl. retail channels, fulfilment methods, payment methods) (iii) Where how to pay for car parking, public charging stations for electric vehicles and refuelling points for CNG/ LNG, hydrogen, petrol and diesel powered vehicles (incl. retail channels, fulfilment methods, payment methods) Trip plans: (i) Detailed cycle network attributes (surface quality, side-by-side cycling, shared surface, on/off road, scenic route, 'walk only', turn or access restrictions (e.g. against flow of traffic) (ii) Parameters needed to calculate an environmental factor such as carbon per vehicle type or passenger mile or per distance walked (iii) Parameters such as fuel consumption needed to calculate cost Trip plan computation: (i) Estimated travel times by day type and time-band by transport mode/combination of transport modes

1.2.3 Key Performance Indicators

Key Performance Indicators (KPIs) for road-based ITS services have been established in order to assist evaluators on the assessment of the impact of ITS service deployment.

Two types of KPIs for an ITS service (or a combination of services) have been defined:
- Deployment KPIs, which are an indicator of the percentage of the road network that is covered by the service,
- Benefit KPIs, which indicate the benefit/impact (in the form of change percentage of a certain aspect) coming from the deployment of the service.

For the evaluation of ITS services, there are KPI definitions developed by DG MOVE, as well as KPIs developed by EU EIP. Both sets of KPIs include related or even directly corresponding KPIs. Representing an agreed shortlist of a wide range of indicators, DG MOVE KPIs have a more generic nature, intended for fulfilling progress reporting duties of Member States to the European Commission in the context of the ITS Directive. EU EIP KPI definitions are more detailed and their use when evaluating ITS deployments could potentially provide additional insights. An informative technical reference document "ITS Deployment and Benefit KPI Definitions"[3] has been released by EU EIP Evaluation. This document includes the KPI definitions in detail, specific examples of KPI calculation, as well as a matrix that relates the EU EIP and DG MOVE KPIs.

In the framework of EU EIP, reported results from ITS deployments stemming mainly from the CEF ITS Corridors (i.e. Arc Atlantique, Crocodile, MedTIS, NEXT-ITS and URSA MAJOR) are collected in two ways:
- from the Corridor Evaluation reports by EU EIP Evaluation,
- from the Deployment References, collected by EU EIP Monitoring and Dissemination.

The latter are provided in Annex A of the Reference Handbook, while the Corridor Evaluation reports can be found in the Evaluation Library of EU EIP[4]. In addition, EU EIP Evaluation has developed a very convenient Evaluation Toolkit[5], which allows users to search for results based on various criteria, e.g. a specific service, ITS Corridor, Benefit KPI etc.

Finally, the very informative publication "Digitalisation of road transport in Europe"[6] by EU EIP contains highlights from the evaluation of the CEF ITS Corridors and summarises the impact and benefits observed from ITS deployment on the Corridors.

1.2.4 Importance of information provision to National Access Points

What is a National Access Point?

A National Access Point (NAP) is a digital interface installed by an EU Member State to make traffic and mobility data accessible for a wide range of data providers and users (see (EU) 2013/886 (SRTI)). NAPs can take the form of a repository, registry, web portal or similar. Each EU Member State is stipulated to establish NAPs to address obligations from the corresponding EC Delegated Regulations. The Delegated Regulations do not specify which form the NAPs should take, however for Delegated Regulation 2017/1926 and 2015/962 NAPs shall provide discovery services to users.

3 https://www.its-platform.eu/filedepot_download/2103/6100
4 https://www.its-platform.eu/EvalLib
5 https://www.its-platform.eu/evaluation-toolkit
6 https://www.its-platform.eu/digitalisation-book

Impact on ITS Core services

The National Access Points are relevant for the European ITS Core Services, since the Delegated Regulations oblige the various actors (road operators, digital map providers, service providers, etc.) to provide access to their data when available in machine readable format, depending on the type of data and under certain conditions. For example:

- truck parking operators should provide as a minimum static information about their truck parking,
- road operators and service providers should provide access
  - to road safety-related traffic information on the trans-European road network (e.g. slippery road, short term road works), as well as
  - real-time traffic information (i.e. static road data, dynamic road status data, traffic data) if available.

In most cases where ITS is applied, related data, which are listed in the delegated regulations, are digitally available and thus should be made accessible for a wide range of data users through the National Access Points. Where applicable the ITS Core Services have been adapted following the obligations from the Delegated Regulations with respect to the National Access Points.

More information on National Access Points

Within the European ITS Platform project one specific activity aimed exclusively at monitoring and harmonisation of these National Access Points across Europe. This activity has produced a number of information materials that can be used by Member States, road operators and information service providers when dealing with National Access Points:

- NAP implementation status annual reports
- Metadata catalogue
- Metadata guideline
- NAP Leaflet
- Uniform Declaration of Compliance for the delegated regulations on:
  - road safety-related minimum universal traffic information ((EU) 2013/886)
  - real-time traffic information services ((EU) 2015/962)
- Digital map providing information and links to existing National Access Points.

All this information can be downloaded from the following weblink: Monitoring and Harmonisation of National Access Points. An overview/list of all national access points is shown here: National Access Points A mechanism for accessing, exchanging and reusing transport related data under Delegated Acts of the ITS Directive (2010/40/EU).

1.2.5 DATEX II

There are several initiatives funded by the EU that address the support and development of the standards used for the ITS Core services described in the handbook. Some examples of these initiatives are the DATEX II group, the Data4PT project or the TN-ITS initiative. Because the handbook draws from the perspective and expertise of road operators, we present below more details about DATEX II group which, out of all initiatives, deals with the most relevant standard for (inter-urban) road transport.

DATEX II is the electronic language used in Europe for the exchange of traffic information and traffic data. The development of DATEX was initiated in the early 90s because of the need to exchange information between traffic centres of motorway operators. Soon there was the need to open this information to service providers. DATEX "I" was strongly linked to the arising standard of road information, ALERT-C for RDS-TMC broadcasting support.

Built with the technical tools and methods of that time, it was too limited for evolving with the Internet boom, which is why DATEX II was developed. By means of DATEX II, traffic information and traffic management information is distributed in a way that is not dependent on language and presentation format, avoiding re-keying, misunderstandings and translation errors by the recipient. Nevertheless, the recipient can still choose to combine it with spoken text, an image on a map, or to integrate it e.g. in a navigation service's route calculation. The increasing scale on which ITS services are being dimensioned, as well as the new digitization requirements arising from self-driving cars, requires increased use of standards and thus also challenges the DATEX II community accordingly.

The DATEX II organisation currently organised as a CEF Programme Support Action (PSA), co-funded by the European Commission (Agreement number MOVE/C3/SUB/2015-547/CEF/PSA/SI2.733309 RWS). DATEX II is open to all stakeholders in the traffic management domain (road authorities and road operators) that want to participate in the development, maintenance and user support of DATEX II.

The governance of the DATEX II organization is controlled by the "Rules of Procedure of the DATEX II organization". These rules apply to all partners in the DATEX II organization.

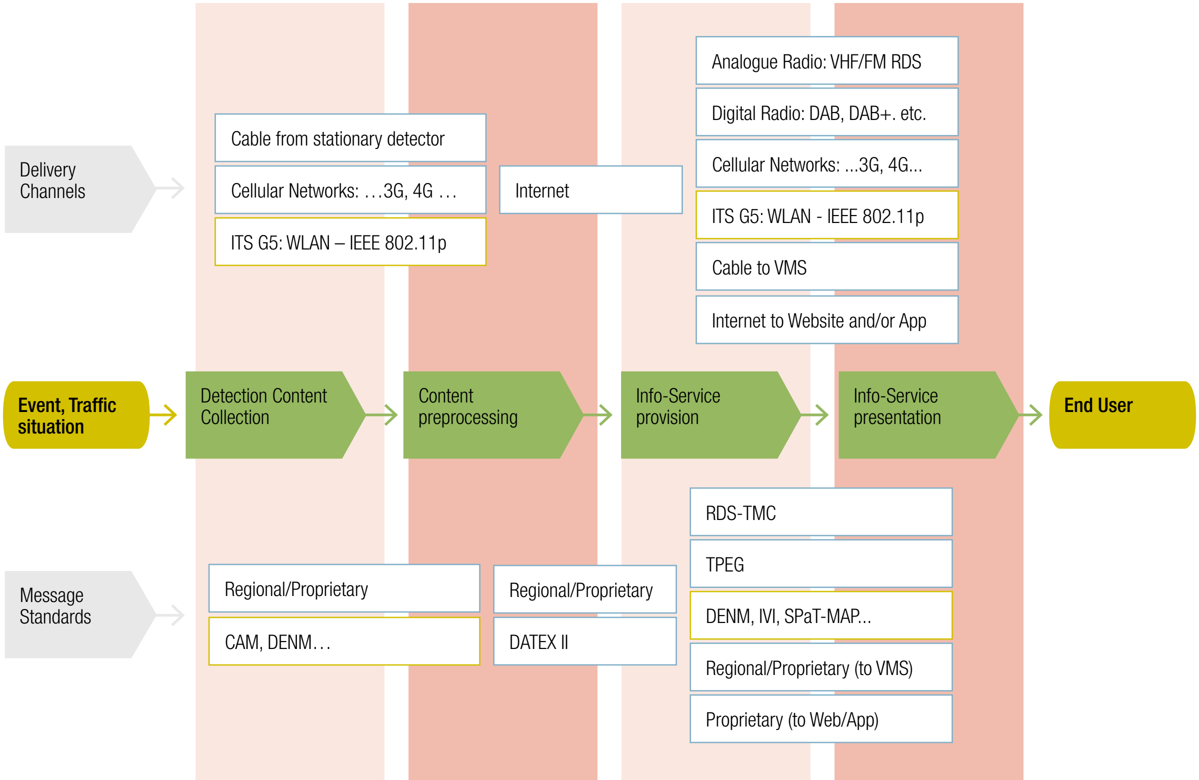
- DATEX II is a multi-part standard, maintained by CEN Technical Committee 278, Intelligent Transport Systems, see www.itsstandards.eu.
- The first three parts and the seventh part of the CEN DATEX II series have already been approved as European Norms CEN EN. Two new parts (part 8 and 9) have been approved as Technical Specifications CEN/TS. It should be noted that DATEX II is currently finalizing a major version update (from 2.x to 3.y – the current version is 3.1), where the Parts 4 and 6 in the table below are still in the finalisation stage to be also re-published. This will finalise the update to major version v3, which is not backwards compatible with v2.x versions.
- CEN EN 16157-1:2018 – Part 1: Context and framework
- CEN EN 16157-2:2019 – Part 2: Location referencing
- CEN EN 16157-3:2018 – Part 3: Situation Publication
- CEN/TS 16157-4:2014 – Part 4: Variable Message Sign (VMS) Publications
- CEN EN 16157-5:2018 – Part 5: Measured and elaborated data publications
- CEN/TS 16157-6:2015 – Part 6: Parking Publications
- CEN EN 16157-7:2018 – Part 7: Common data elements
- CEN/TS 16157-8:2020 – Part 8: Traffic management publications and extensions dedicated to the urban environment
- CEN/TS 16157-9:2020 – Part 9: Traffic signal management publications dedicated to the urban environment..

1.2.6 European Member States C-ROADS Platform

The delivery of ITS Core services to road users has evolved and used a multitude of communication channels (e.g. spoken traffic information in FM radio, Variable Message Signs, Internet portals) since decades. This is the basic idea behind the illustration in Figure 3.

When looking to the content segment, road authorities and operators have traditionally heavily relied on own detectors along their network, complemented by e.g. Floating Phone Data / Floating Car Data and incident reporting by road users. This delivery process including its sourcing is represented in the stylised value chain for traffic information.

Figure 2: **Integrating Cooperative ITS into the value chain for traffic information**



Based on work and discussions within TISA and CEDR.

The advent of Cooperative ITS (C-ITS) has opened up another channel to this value chain (highlighted in Figure 2 in yellow). For simplification reasons we stick here to the linear value chain and do not argue on C-ITS leading to a circular information flow or even a value web, as discussed elsewhere[7]. C-ITS is defined according to standardisation in CEN/ISO and ETSI as a subset of the overall ITS that communicates and shares information between ITS Stations (ITS-Ss) to give advice or take actions with the objective of improving safety, sustainability, efficiency and comfort beyond the scope of stand-alone ITS. The definition embraces the concept of ITS Stations that can be located either in vehicles, at the roadside, in the traffic control centre or related to personal mobile devices. The Delegated Regulation on C-ITS - which has been adopted by European Commission on 13.03.2019 but has not come into force - has emphasised the peer-to-peer network character as well as its security and trust implications. It has defined C-ITS as intelligent transport systems that enable ITS users to cooperate by exchanging secured and trusted messages using the EU C-ITS security credential management system (see https://cpoc.jrc.ec.europa.eu/ for more detail)

As it is illustrated in Figure 2 C-ITS represents another content source and communication channel into the vehicles. As stated in the European C-ITS strategy (COM (2016) 766), a C-ITS message can be communicated in the vicinity by WLAN 802.11p (short range communication) or by existing cellular networks (long range communication). These communication technologies have been tested by road authorities and operators for several years (Field Operational Tests, Pilots and Deployment Initiatives) and can be considered mature for provision of initial C-ITS services. For C-ITS via short range communication, the operational roll-out started and relevant corresponding requirements and specifications are included in the ITS service descriptions.

7 Berndt et al. 2018: Coordination and Support Action COoperative ITS DEployment Coordination Support, Deliverable 2.6 Deployment Guidance CODECS

Developments in progress that are not (yet) represented in Figure 2 comprise the following streams:

— Alternative technologies for short range communication are meanwhile specified (LTE V2X as part of 3GPPP Release 14) and increasingly tested under different conditions (e.g. lab, test track). The commercial availability of LTE V2X equipment however remains a challenge, at least for the European market (JRC 2019). Specifications have evolved towards 5G V2X and 5G-NR as part of 3GPPP Release 16 in 2020.

— Data from vehicles can serve as a valuable source of Safety Related Traffic Information (SRTI). A Proof-of-Concept of the Data Task Force of the High-Level Meeting on Connected and Automated Driving involves Member States, OEMs and service providers. The One-Year-Proof-of-Concept has led to the establishment of a Data For Road Safety Ecosystem in 2020 based on a Multi Part Agreement (see www.dataforroadsafety.eu). It aims at a collaborative effort to share data while supporting road safety.

It should be noted that these evolving technologies create a dynamic environment of new connectivity and data sharing environments. Further new approaches ahead are Mobile Edge Computing technologies as well as data spaces driven by mobility dataspace developments and the GAIA-X initiative on European level. All these technologies are likely to influence the future data sharing environment of the ITS Services described in this Reference Handbook and will be addressed in the service descriptions in future iterations.

The initial deployment of mature C-ITS services is organised via Member State driven C-ITS pilots that collaborate in the C-Roads Platform. This flagship, comprising of currently 18 European states, collaborates on harmonised specifications and communication profiles. The Release 2.0 of C-Roads harmonised C-ITS specifications, published in September 2021, contains a bundle of documents:

— C-ITS Message Profiles,

— Common C-ITS Service and Use Case Definitions,

— Roadside ITS-G5 System Profile,

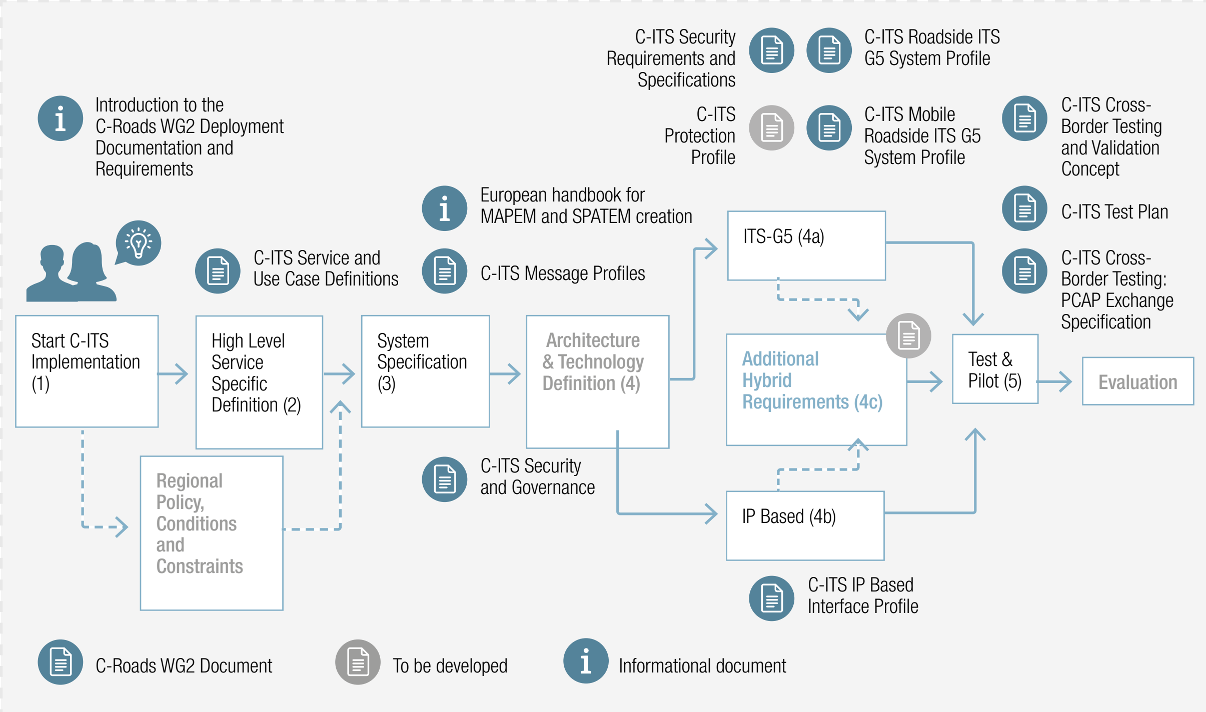
— Mobile ITS-G5 System Profile,

— C-ITS IP based Interface Profile.

Note: C-Roads is constantly evolving. The latest versions can be downloaded from the C-ROADS website (see https://www.c-roads.eu/platform/get-in-touch.html).

The process towards the C-ITS deployment documentation and requirement is illustrated in Figure 3.

Figure 3: **C-ROADS Working Group 2: C-ITS Deployment Documentation and requirements**



1.2.7 Further relevant Programme Support Actions (PSA)

1.2.7.1 FRAME NEXT

The FRAME Architecture (originally called the European ITS Framework Architecture) offers a functional architecture for all different areas of Intelligent Transport Systems. It provides a systematic basis for planning ITS implementations and facilitates their integration when multiple systems are to be deployed. From a large repository, the FRAME user can choose a sub-set of functionalities which are to be supported by the ITS service or services to be planned. FRAME then displays the kinds of data which have to be exchanged between different functionalities and with external stakeholders.

In the CEF Programme Support Action FRAME NEXT, the FRAME Architecture is currently being updated and extended. A new tool - which uses the software Enterprise Architect similar to the DATEX II development - facilitates browsing the repository and the architecture modelling process. FRAME does not mandate any physical or organisational structure. However, the updated version reflects the Delegated Regulations under the ITS Directive (section 1.2.2) and gives examples of the effects on stakeholder agreements and communications architecture. Due to the origin of FRAME and in contrast to this handbook, the focus is more on the interaction of different functionalities within the ITS environment of an organisation. Interfaces to the outside of this organisation-internal ITS environment are also shown and described on a functional level and – where applicable according to the Delegated Regulations – with communications and stakeholder agreements. More information: www.frame-next.eu

1.2.7.2 TN-ITS

Digital maps for ITS must always be up to date for attributes that are critical in terms of safety and efficiency. However, it is very difficult for map providers to keep their maps up to date for those attributes. The mission of TN-ITS is to facilitate and foster the exchange of ITS-related spatial road data between road authorities as trusted data providers and data users as map makers and other parties. The focus of data exchange is in general on road attributes based on regulations (static road attributes), but may extend to other road and transport related features.

Within TN-ITS, map makers and public authorities work together and support EC policy to update static road data and ensure a seamless data chain. They provide guidelines and tools to support implementation as well as define and maintain TN-ITS specification in CEN/TC 278/WG7. The benefits of the project include the improvement and frequent update of maps for traffic and ADAS services, an M2M data interface, an authoritative data feed for public use and in general a contribution to seamless ITS services and safer and more efficient driving.
More information: www.tn-its.eu

1.2.7.3 Data4PT

Public transport services rely increasingly on information systems to ensure reliable, efficient operation as well as widely accessible, accurate passenger information. These systems are used for a range of specific purposes such as setting schedules and timetables, managing vehicle fleets, issuing tickets and providing real time service information. Data plays a very important role in a well-functioning public transport system and large amounts of data are collected by the providers to enhance their services.

Data4PT's overall objective is to support the development of harmonized European public data exchange standards (Transmodel, NeTEx and SIRI) and enhance partnerships amongst public authorities and travel information service providers. These standards will provide Union-wide multimodal travel information services which apply to the TEN-T network, including urban nodes. Aim of the project is to enable EU-wide multimodal travel information services and contribute to a seamless door-to-door travel ecosystem across Europe, covering all mobility services.

More information: www.data4pt-project.eu

1.2.7.4 IDACS

In the framework of the IDACS PSA, the 16 partners/member states will establish, at national levels, a uniform methodological approach identifying and monitoring the existing and emerging charging infrastructure for electric vehicles and vehicles to other alternative fuel sources. The objectives of the project are the following:
— Develop harmonised e-mobility Identification Codes for Charging Point Operators and e-mobility service providers at EU level, for the purpose of identifying the contract, charging station, charging provider.
— Implement an ID registration repository for exchanging information on the developed e-mobility ID codes;
— Ensure that all information is made available through national contact points (in accordance with ITS Directive 2010/40 / EU)."

— Raise consumer awareness on existing recharging infrastructure and the availability of alternative fuels
— Support structured market development through a common approach at EU level.

More information: https://ec.europa.eu/transport/content/programme-support-action-addressed-member-states-data-collection-related_en

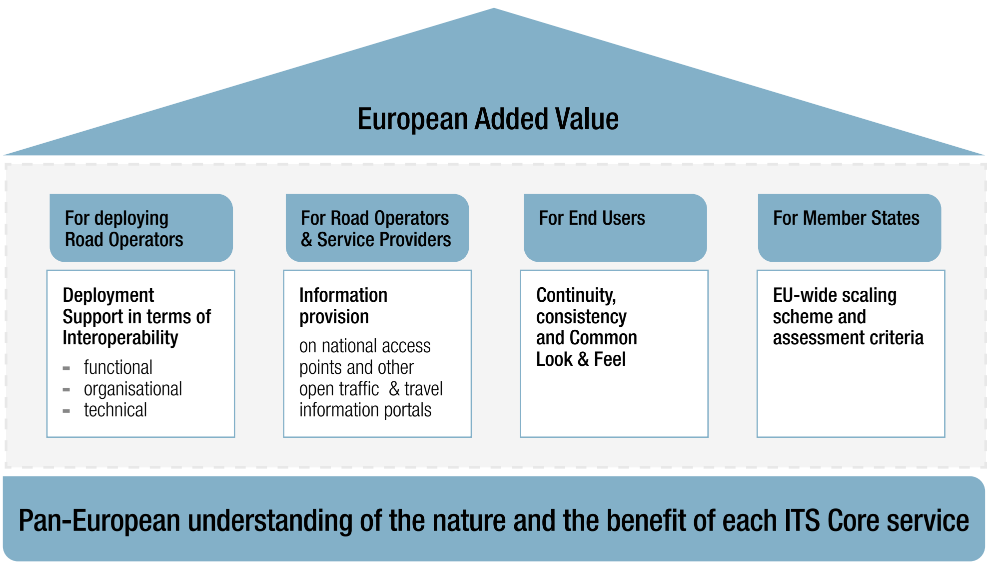
1.3 Scope and pillars of harmonisation and interoperability in this handbook

The intention of the ITS Service Deployment Reference Handbook is not to deal with the detailed specification of ITS Services to suit the requirements for tendering of systems through, for instance, suggesting a common European-wide system architecture for ITS services.

Instead it seeks to facilitate the adjustment to existing specifications and best practice in four areas where European added value can be achieved for four user groups. These areas are:
— Interoperability in terms of functional and organisational requirements and the use of standards to harmonise cooperation and collaboration between different road operators and other third parties involved in the deployment and operation of an ITS Core service
— Information provision and acquisition on national access points and C-ITS interfaces
— Common Look & Feel to present ITS Core services to the end user in a harmonized European way
— European-wide accepted assessment criteria to offer assessment against the background of harmonized level of service and operational environment criteria.

The four different user groups where the above will generate European added value benefits are depicted as four main pillars in Figure 5.

Figure 4: **Fundament and pillars of harmonisation**



1.4 Guidance for reading this handbook

The content is aimed at individuals and organisations operating at political and policy development level, from implementors to engineers. It is therefore not aimed at a single user group, but rather at anyone involved in the decision, implementation, deployment, operating and quality control process of an ITS Core service.

To allow rapid assimilation, Table 5 provides a quick reference to pertinent chapters within the reference handbook based on the potential audience/interest group for this document and where the reader might be situated in the decision-making chain. For the convenience of the readers, the key chapters for the defined user groups are marked accordingly with a pictogram next to the chapter heading.

Table 5: **Reading Guidance for this handbook**

Level	Involvement	Key chapters
Strategic bodies	Discussion in political bodies, decisions and setting budgets	1.1 Significance and background of the Handbook 1.2 References to European background activities 1.3 Scope and pillars of harmonisation and interoperability in this handbook 1.4 Guidance for reading this handbook
	Implementation of political decisions, monitoring of implementation	1.1 Significance and background of the Handbook 1.2 References to European background activities 1.3 Scope and pillars of harmonisation and interoperability in this handbook 1.4 Guidance for reading this handbook 2 The conceptual setup
Implementation managers	Managing and controlling of the ITS-core service deployment	2 The conceptual setup 3.1 TTIS-Introduction 4.1 TMS-Introduction 5.1 F&LS-Introduction
	Design of the ITS-Core Service to deploy	2 The conceptual setup Introduction referencing to ITS-Core service to deploy ITS-Service Description of the ITS-Core service to deploy Annexes referencing to ITS-Core service to deploy
	Deployment of the ITS-Core Service	2 The conceptual setup Introduction referencing to ITS-Core service to deploy ITS-Service Description of the ITS-Core service to deploy Annexes referencing to ITS-Core service to deploy
Expert Engineers	Software design and development of the ITS-Core Service	2 The conceptual setup Introduction referencing to ITS-Core service to deploy ITS-Service Description of the ITS-Core service to deploy Annexes referencing to ITS-Core service to deploy
	Operating of the ITS-Core Service	ITS-Service Description of the ITS-Core service to deploy
	Evaluation of the impact of the ITS-Core Service	Quality aspects description of the ITS-Core service to deploy

2
The conceptual setup

1 European ITS Service Deployment Reference Handbook

1.1 Significance and background of the Handbook

Purpose and aim

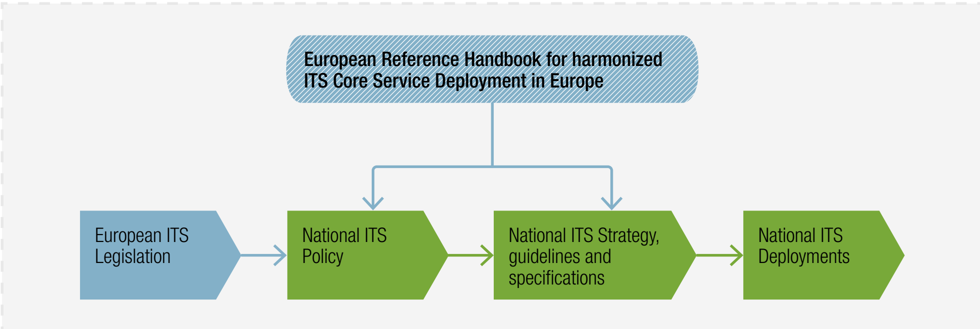
This handbook comprises a series of guidance and advice for use by road authorities and operators to support them in development of their strategic approach, design development, deployment, installation and operation of Intelligent Transport Systems and Services (ITS) and remain compliant with EU legislation.

The purpose of these guidance is to assist Member States in taking a broadly similar approach so wider European added value can be achieved, whilst at the same delivering the needs of individual Member States.

On the one hand, the EU Delegate Regulations - published in 2013 - 2019 - and the Guidelines for the practical implementation and use of ITS services - adopted by 17 Member States as early as 2012 - have emerged at very different times. On the other hand, their focus and objectives are very different, the authors were particularly keen to use this handbook to build a bridge between the more strategic Delegate Regulations and the functional, organisational and technical Deployment Guidelines.

Against this background, Member States are recommended to translate the handbook into their national language. So all persons involved in the implementation of ITS services - each at his or her own level - can not only benefit from the important requirements laid down in the handbook, but can also be sure that each national ITS deployment will comply with the requirements of the EU delegated regulations for ITS.

Figure 1: **Integration of the ITS Reference Handbook in national specifications**



2 The conceptual setup

2.1 The European ITS Core services structure model

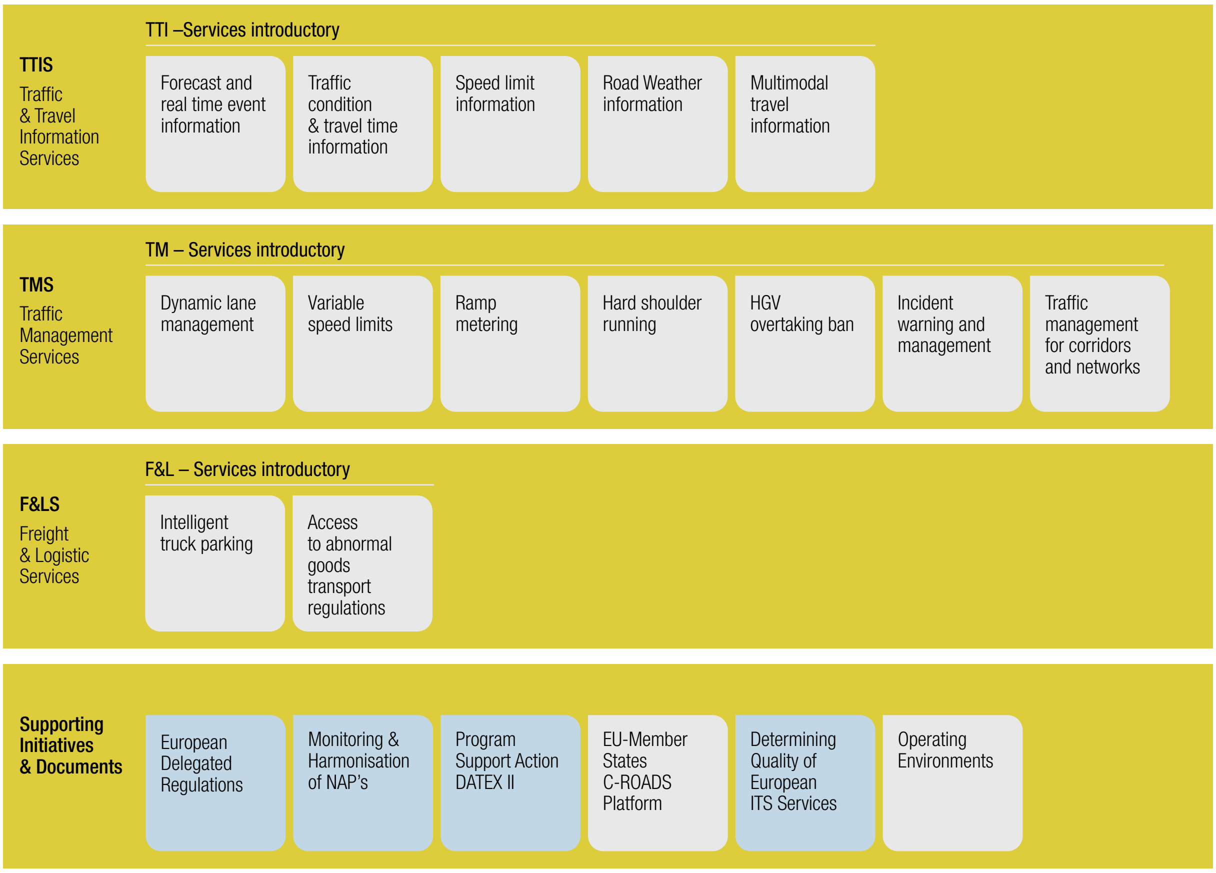
The bundle of European ITS Core services comprises of three ITS Service categories with in total 14 specific ITS Services. The categories are:
— TTIS - Traffic and Travel Information Services,
— TMS - Traffic Management Services and
— F&LS - Freight & Logistic Services.

Whilst TTIS - Traffic and Travel Information Services are primarily focused on the end-users as travellers to provide to them pre-trip and on-trip information about the situation during their journey, TMS - Traffic Management Services represent a set of instruments for road operators to directly influence the driver while driving or, in the case of Traffic Management for Corridors and Networks, to align his traffic behaviour with the overarching strategies of public and private road operators traffic management.

The F&LS - Freight & Logistic Services represent a special case. Intelligent Truck Parking informs about possible parking spaces at motorways for trucks and Access to Abnormal Goods Transport Regulations is an internet-based tool to register dangerous goods transports.

The overall structure and composition of the three categories and the specific ITS Core services included can be seen in Figure 6.

Figure 5: **European ITS Core services structure model**



Part of the ITS Core services structure model are also a bundle of supporting activities and documents whose results have a structural and content-related influence on the ITS Core services and are shown in the bottom line of the ITS Core services structure model figure (see Figure 5). In addition to the Delegated Regulations and related activities (in Figure 5 with blue background), various other activities (i.e. of the EU-EIP platform, C-ROADS, DATEX II, TN-ITS and Data4PT) are worth mentioning here.

2.2 The common ITS service description structure

Following the overall harmonisation concept, the description structure of the ITS Core services in this handbook consists of several parts, which are depicted in Figure 6:

Figure 6: **The common ITS service description standard**

ITS-Service deployment guidelines description structure

Per set of TTI-, TM & F&L services: Introductory

ITS service at a glance	**Harmonisation requirements and advice**
ITS service profile*	Functional requirements and advice
General ITS service description	Interface requirements
What is the vision?	Common look&feel requirements and advice
What is the mission?	ICT requirements and advice
Distinctiveness to other ITS-Services	Required standards and specifications
* only for TM and F&L services ** only for TTI and F&L services	Level of (quality &**) service definition

Annexes:	A: Deployment References	B: Compliance Checklists	C: Operating environment classification

Per set of TTI, TM, and F&L services an **introduction** is available, where decision makers find all basic/general and strategic information bundling content that is common to all TTI respectively TM and F&L services.

The **ITS service at a glance** gives a very brief overview of the nature of the service.

The section **ITS service profile** gives an overall explanation of the ITS Core service.

— Decision makers find all basic/general and strategic information (vision and mission) about the particular ITS Core service,
— the profile of this particular ITS Core service compared to the other ITS Core services is highlighted

The section **Harmonization requirements and advice** delivers answers in form of requirements and advice to questions around what is needed for a harmonised deployment of European ITS Core services:

— to ensure interoperability/continuity on the functional and organisational with a similar neighbouring ITS Core service provided by another organisation
— to present itself to the road user with a common harmonized European look and feel
— to ensure the use of ICT infrastructure appropriate to the ITS Core service needs
— to ensure the use of the right information provision standards and specifications on national access point and C-ITS interfaces
— to offer assessment based on harmonised level of quality[8], service and operational environment criteria.

Annex A delivers a collection references to existing deployments (partly or complete conform to this Reference Handbook)

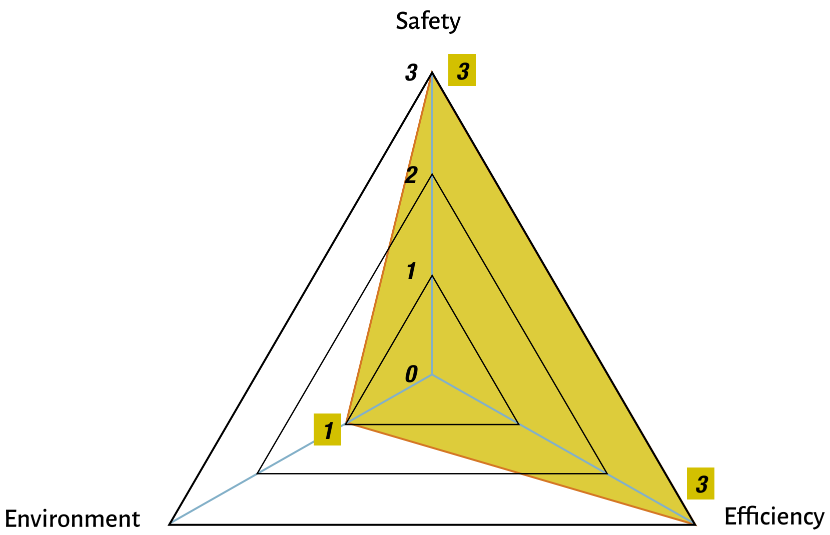
Annex B lists mandatory features required for a harmonized ITS Core service deployment in form of a table named "compliance checklist"

Annex C gives and explains the concept of the Operating Environments

2.3 The ITS Service Radar concept

The ITS Service Radar graph shows a quantification of the added value of each ITS-service regarding the following three objectives: safety, efficiency and the environment. Figure 7 shows an example of an ITS Service Radar for the Forecast and Real-time Event Information service.

Figure 7: **ITS-Core Service Radar for the Forecast and Real-time Event Information service**



The service radar graphs have been developed as a way to visualise the possible impact of the deployment of the ITS core service on each of the objectives. The ratings awarded to each objective range between 0-3, with 0 for no expected impact and 3 for a high impact. They have been formed using the following sources of information:

8 Level of quality criteria are only defined for TTI and F&L services

- An extensive literature research conducted within the NEXT-ITS CEF ITS Corridor, which covers many ITS core services included in this handbook.
- Useful conclusions and outcomes from the CEF ITS Corridor implementations, as reflected in the Evaluation Reports of each Corridor[9] and the EU EIP Evaluation Toolkit[10].
- A complementary literature research conducted by EU EIP experts focusing mainly on experiences and evaluations from all over Europe.
- Discussion within the respective Expert Group of the EU EIP Monitoring and Dissemination activity, the opinion of the ITS core service coordinator (expert of EU EIP with significant experience on the subject) for each service, as well as input from the EU EIP Evaluation activity.
- Additional insights submitted by external reviewers as part of the review phase of the handbook.

It has to be noted that the purpose of the Service Radars is not to rank the services against each other, but to provide the reader with an easy to understand, visual first idea of the expected impact of each service. They are not in relation to each other and they are not directly comparable. A main reason is that the availability of evaluation results in literature is not equal for all services, making it necessary in a few cases to rely more heavily on qualitative assessments of experts, different for each service. Therefore, although great care has been taken in the development process, so as to create a rating fundament that is as objective as possible, a comparison of Service Radars of different services is not recommended.

2.4 The Harmonization requirements and advice concept

Purpose and aim

As the primary objective of this handbook is the harmonisation of the ITS service deployment throughout Europe, the "harmonisation and advice concept" is the very core of the handbook. Here, for each of the European ITS Core Services, requirements and advice are formulated from a pan-European perspective in such a way that

- functional, organisational and technical interoperability between the ITS services is achieved
- the end user, irrespective of the European country in which he/she is travelling, can perceive and use the services offered in the same or at least a similar way
- uniform implementation and evaluation benchmarks for the deployment of ITS Core services are available to the acting road operators when they intend to implement a new ITS service or improve an existing ITS service.

The Must, Should & May requirement principle

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 this ITS Reference Handbook, the well-established provisions of the RFC 2119 are used, which is used to specify the basic Internet standards:

The ITS service 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 chapter Harmonization requirements and advice is provided in Table 6.

9 A comprehensive collection of Evaluation Reports and further relevant evaluation documents from the CEF ITS Corridors can be found in the EU EIP Evaluation Library (https://www.its-platform.eu/EvalLib).
10 https://www.its-platform.eu/evaluation-toolkit

Table 6: **Requirement wording**

<table>
<tr><th>Requirement wording</th><th>Meaning in RFC 2119</th><th>Meaning in this handbook</th><th>Possible checklist answers</th></tr>
<tr><td>MUST
(REQUIRED, SHALL)</td><td>the definition is an absolute requirement</td><td rowspan="2">there may exist insurmountable reasons to not fulfill (e.g. legal regulations…), which can be quoted</td><td rowspan="2">fulfilled: yes
or
Fulfilled: no – quote of insurmountable reasons</td></tr>
<tr><td>MUST NOT
(SHALL NOT)</td><td>the definition is an absolute prohibition</td></tr>
<tr><td>SHOULD
(RECOMMENDED)</td><td>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.</td><td rowspan="2">The Definition is very close to a “MUST”, “MUST NOT” Meaning in this handbook conform to RFC 2119, that means a “no” must be supported by very clearly described and for third parties comprehensible and traceable reasons</td><td rowspan="2">fulfilled: yes
or
Fulfilled: no - with explanation</td></tr>
<tr><td>SHOULD NOT
(NOT RECOMMENDED)</td><td>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</td></tr>
<tr><td>MAY
(OPTIONAL)</td><td>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</td><td>Meaning in this handbook conform to RFC 2119</td><td>fulfilled: yes - with explanation
or
Fulfilled: no</td></tr>
</table>

In general, the keywords in brackets are possible, but their use is not recommended in order to avoid confusion which may arise because of different common linguistic usage of the terms in the different EU member states.

Note: the capitalisation of these keywords that is frequently used in Internet standards is not recommended for the ITS Deployment Reference Handbook.

The use of this “*requirements language*” allows the direct transfer of the requirements stated in chapter Harmonization requirements and advice to a compliance checklist.

The harmonization requirements and advice chapters and sections

Against this background, the manual provides a formal ITS service definition and requirements and advice in a total of 6 chapters:

Service definition

— Determination of a de facto linguistic term usage or a fixation of a linguistic term usage; Text provided is not a description but a short and precisely formulated definition.

Functional requirements and advice

— This chapter illustrates the functional architecture/structure of the service in a way that the typical main functions from data collection to information provision to the end user are depicted and identifiable.

Interface requirements

— This chapter defines the information structure for data exchange, as far as relevant with reference to and in conformity with the Delegated Regulations of the ITS Directive 2010/40. Such information requirements are called “Interface requirements”.

Organisational requirements

— This chapter describes the organisational architecture/structure of the service in a way that the typical main organisational roles (of the service value chain) are identifiable and that the contractual basis of their cooperation and the principles of how they work together in operations become visible.

Common Look & Feel requirements

— Harmonisation focus of this chapter is the "User service perception" with the intention to enable the users and partly also the operators of the service to experience a common look & feel wherever they use the service.

ICT infrastructure requirements

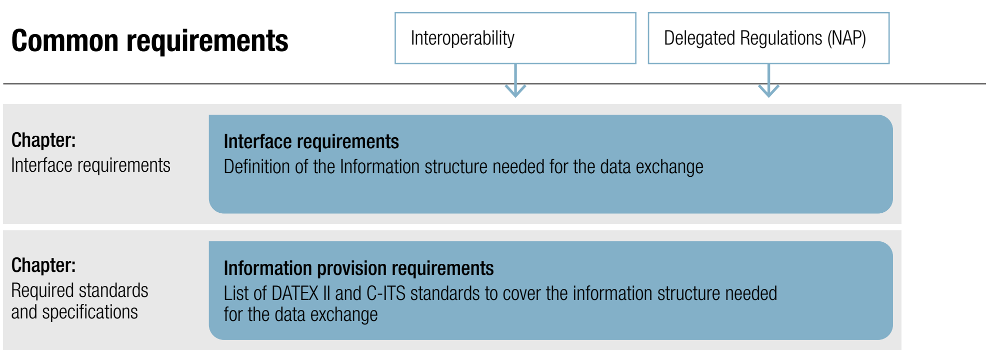
— This chapter is intended to list and illustrate technical standards which are useful/necessary to improve interoperability between organisations and technical systems they use to operate the service. As the handbook is intended to foster only harmonization of ITS services it is not necessary to address technical details which are required to implement the functions of the service itself (as it would be necessary in the context of a tender).

Required standards and specifications

— When needed and relevant for the particular service, this chapter contains normative references to standard(s) required for implementation and/or operation of the service and in those cases where the service depends on particular data definitions and/or e.g. special recommendations on the use of VMS (see 4.3.3.6)

— In the section "information provision standards", standards, that are required to implement the above-mentioned "Interface requirements", are formally listed and, if necessary, for better understanding described verbally. A digital tool for creating DATEX II profiles according to the specified requirements is available on the website www.datex2.eu. It will help developers implement ITS services.

Figure 8: **Steps describing requirements interfaces for information exchange**



Level of Service Definition

— The harmonisation focus of this chapter is on the European level agreed service assessment criteria. The section "Level of service criteria" provides a (common) definition of possible levels of service (LoS) for the different characteristic elements of an ITS service. The section "Level of Service Criteria related to Operating Environment" maps the possible range from minimum to optimum level of service for each of these characteristics, hence supporting harmonised deployment of services throughout Europe.

2.5 How ITS Core services share information

2.5.1 Interface implementation model

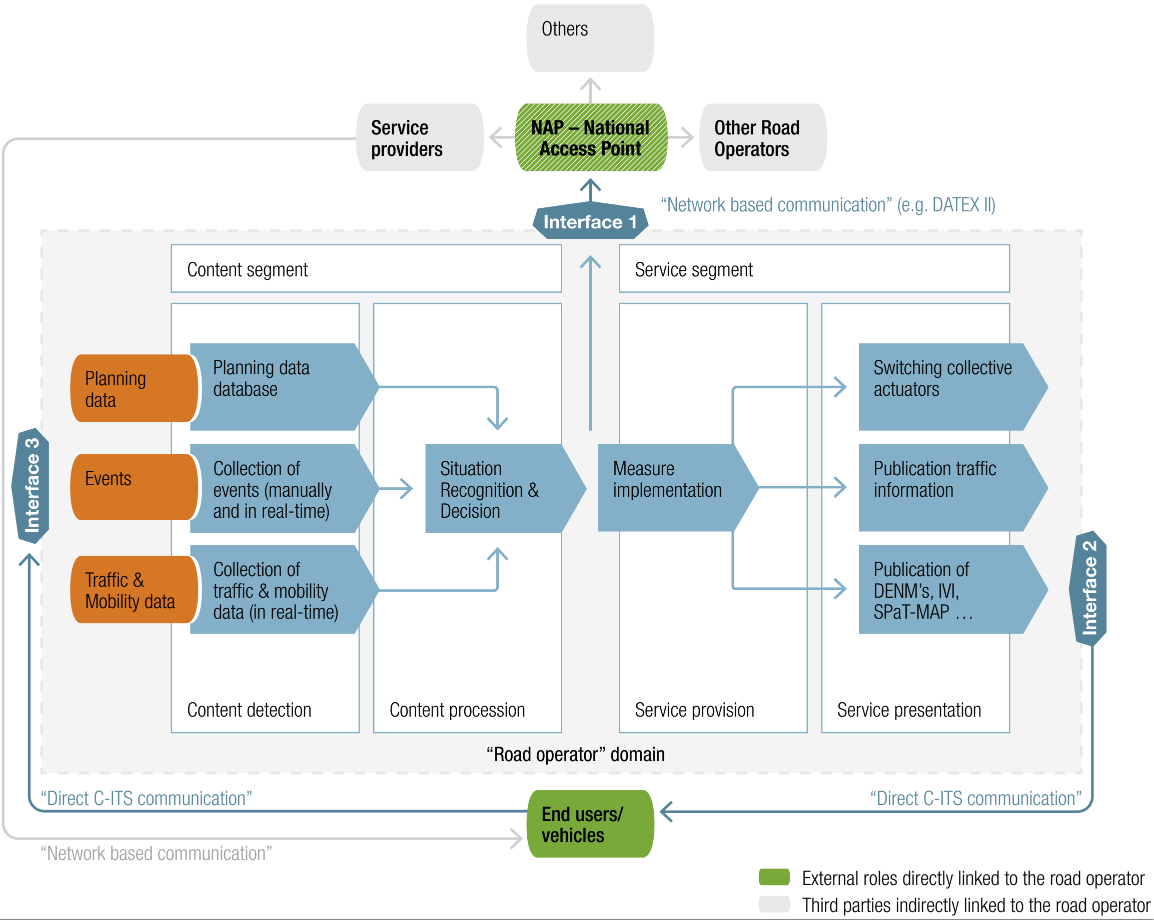
All ITS applications process digital data, some of them process data that is input from other systems and some produce data that needs to be sent out to other systems. This introduction describes the data sharing context of the ITS services in a technology agnostic way. These requirements reflect the regulatory context as well as the technical conditions at the time when this text was written.

In subsequent chapters, the current technical implementation options for the interfaces are described, based on mature technologies available for operational roll-out and also based on current relevant regulation.

Note: Other technical options are currently considered in the context of R&I projects, but these have not reached a level of maturity yet for everyday operation.

The structure for describing the data sharing context of the ITS Core services described in this Reference Handbook is depicted in Figure 9.

Figure 9: **Data sharing architecture (Road operator view)**



The centre of the diagram represents the road operator domain with the ITS service and its system boundary. The value chain overview - depicted in the background - is used as a symbol for the road operator processes. On the service boundary – depicted by a grey dotted line – we see three interfaces, which are served with two types of communication (network based communication, direct communication).

- **Interface 1** realises a backbone interface that allows the service to communicate via NAPs with other third party backbone systems (depicted in grey). Other backbone systems may be those of other road operators, service providers for vehicle fleets or end-user applications operated inside the vehicle, or other systems (see below and section 1.2.4 for the NAP roles).
- **Interfaces 2** and **3** describe direct communication links (i.e. via RSUs) between the road operator and individual vehicles (i.e. via OBUs) or other devices used inside the vehicle e.g. smartphones
  - **Interface 2** is the interface to convey information from the service into the vehicles or the user device
  - **Interface 3** is the interface for in-vehicle data being transmitted from the vehicle/user device to the service as a source data.

As stated above, the description so far was technology agnostic. In order to do actual implementations of the service, concrete technologies have to be selected to implement these interfaces. The requirements presented in this document will provide the required choices regarding technologies and data profiles. The requirements regarding Interface 1 are mainly governed by the Delegated Regulations published by the European Commission in the scope of the ITS Directive. These stipulate the use of National Access Points and the application of DATEX II standard (CEN 16157 series) for most data encoding. A building block of such profiles are the Recommended Service Profiles (RSP).

Communication with connected vehicles based on cellular radio technology to convey backbone data exchanged via Interface 1 into vehicles is mature and well established. Mature technologies for implementing Interface 2 and Interface 3 are currently limited to C-ITS based on ITS G5 (see comments in chapter 1.2.6). The requirements stated will directly refer to the two guiding specifications for infrastructure to vehicle (I2V) and vehicle to infrastructure (V2I) communication. These are the C-Roads “harmonised communication profile” (for I2V on Interface 2) and the “Basic System Profile” published by the CAR2CAR Communication Consortium (for V2I on Interface 3). A second indirect channel to exchange information with the end user/vehicle (see Figure 9) is currently also under specification (specification for interoperability of back-end hybrid C-ITS communication) in the C-ROADS project.

A second indirect channel to exchange information with the end user/vehicle (see Figure 9) is currently also under specification (C-ITS IP Based Interface Profile) in the C-ROADS project.

Subsequent sections will provide general introductions into the underlying technologies, and will specify for each ITS service the functional, technology agnostic requirements for data sharing as well as the required requirements for concrete standards and specifications for the currently available technologies. It should be noted that the development of connectivity technology for ITS is currently progressing fast and these requirements will require periodic update to keep pace with the evolving technology options. It is also challenging for users of the different types of interfaces to ensure consistency between the information provided via these disparate channels. Note that there is an increasing effort to support consistency with guiding documentation. In particular for safety related information, a cooperation of various actors has produced a document to relate the different implementation technologies to the concepts of the respective Delegated Regulation

(EU) 886/2013. This document can be found at: [Safety related message sets – Selection of DATEX II Situations, DENM and TPEG2-TEC Causes and TMC Events for EC high level categories.]

2.5.2 Required interface standards and specifications

2.5.2.1 DATEX II

For most of the IF1 interfaces, DATEX II, the European standard for the exchange of traffic information and traffic data must be used. It is standardised in the CEN/TS 16157 and EN 16157 series. The most relevant part of this series for the IF1 interfaces is Part 3, “Situation Publication”, which offers the data model for traffic related messages (for example safety related or real-time event information, incidents, …) and operator actions (for example most of the traffic management services). DATEX II covers a wide spectrum of Location Reference standards that can be used to describe the location of the given event or measure.

To use the wide spectrum of the DATEX data model, it is recommended to use so called DATEX II Profiles, which are tailored sets of elements that are relevant for the specific use case or information need. Thus, a profile is always a subset of the overall DATEX II model (“Level A”), because single elements or even complete branches of the model can be deselected. It is also possible to sharpen multiplicity restrictions, i.e. for example to make optional DATEX II elements mandatory in the profile.

A building block of such profiles are the Recommended Service Profiles (RSP) mentioned in this handbook and created by the DATEX II PSA organization. An RSP contains basic elements that a specific profile must contain, i.e. a RSP forms the base on which upon a specific profile will be created. It is possible (but not recommended) to remove elements from the RSP for the specific profile. On the other hand, it is recommended to add further elements to enrich the profile for the data elements available from a specific data supplier. A number of different RSPs are declared in this document to be used for the different services. It is important to stress, that not only the RSP itself can be used, but also a specific profile created out of this RSP. To find the RSPs and to create a profile, the DATEX II Schema generation tool should be used. This tool can be found at https://webtool.datex2.eu/.

2.5.2.2 C-ITS

For the interfaces 2 and 3, C-ITS based on ITS-G5 is to be used. Note that meanwhile a comparable access technology has been developed in the scope of the set of standards for cellular radio networks, called C-V2X. Since this is not readily available on the market for every-day operation yet, it is currently not yet referred to in this handbook, which may change in the future and would lead specifications which are an alternative to ITS-G.

For interface 2, the most relevant documents are the “C-ROADS C-ITS Message Profiles” and the “C-ROADS Common C-ITS Service and Use Case Definitions”, which describe the C-ITS services and use cases and the messages sent out by the infrastructure. For interface 3, the CAR 2 CAR Communication Consortium “Basic System Profile” defines the services and messages, which are sent out by vehicles.

The I2V communication in this reference handbook is mainly done via Infrastructure to Vehicle

Information Messages (IVIM) and Decentralized Environmental Notification Messages (DENM), which are standardized in the ISO/TS 19321 and ETSI EN 302 627-3. However, the usage of the services is defined in the "C-ROADS Common C-ITS Service and Use Case Definitions".

In the Service Definitions, each service (for example In-Vehicle Signage) is described according to the following scheme: at first, the service in general is defined using the keywords Summary, Background, Objective, Expected Benefits and Use Cases. After that, each use case is introduced using similar keywords. Subsequently follows a use case description regarding Situation, Logic of transmission, Actors and relations, Use case scenario(s), Display / Alert principle, Functional constraints / dependencies and Relation to C-Roads C-ITS Message Profiles.

The V2I communication is mainly done via DENM and Cooperative Awareness Messages (CAM), which are standardized in the ETSI EN 302 627-3 and ETSI EN 302 537-2. The usage of these messages and the according services is also defined in the CAR 2 CAR Communication Consortium "Basic System Profile", especially in the "Triggering Conditions" documents. The CAR 2 CAR Communication Consortium documents define the requirements for sending out messages and the contents of the messages.

The usage of the C-ITS services and use cases is dependent on the infrastructure available. In this document, a number of C-ITS use cases are declared to be used for the different services.

2.6 The Level of Service and Operating Environment concept

Besides content and functionality also the availability and the level of service of European ITS Core services are subject of harmonisation: "*Road users shall be able to expect a certain Level of service offer in a specific Road environment!*"

In order to be able to bindingly define such a road class and traffic problem-based Level of Service offer, two basic concepts and one matching concept have been developed. In combination, they result in a specific ITS service setup pattern for each ITS-core service. Road operators can orient themselves on this pattern when rolling out their ITS services.

The Concept of Operating Environments

An Operating Environment means the category of the road section classified according to types and service levels of ITS services typically expected to be operated and often provided on it by the road authorities and operators. Thereby, the Operating Environment is closely related to the expected service levels of the travellers and hauliers using the road section, the frequently occurring or threatening problems of the section, and the feasibility of possible ITS solutions to deal with these problems. The main properties of the road section affecting the Operating Environment are its physical characteristics, network typology, and the frequency and severity of traffic flow and road safety concerns on the section.

There are 14 pre-defined Operating Environments where each Operating Environment is a combination of three criteria:
— Physical characteristics – Motorways or other 2/3/4 lane roads
— Network typology or traffic management orientation – Corridor, Network, Link or Critical spot
— Traffic characteristics – Traffic flow and road safety situations (with optional additions).

In addition, a specific road section may be characterized by attributes such as recurring weather problems, a particular sensitivity for environmental impacts or particular importance for freight transport. The classification method allows for such attributes to be added to the Operating Environment identified.

Chapter 8 (Annex C) gives more information on the criteria and their use in the Operating Environment classification. This is essential especially, if the reader wishes to find out about the methods used for classifying whether there are road safety or traffic flow concerns or not, or if the reader wishes to make a classification of his/her road network.

The Operating Environments proposed for European ITS Core services are defined in a step-by-step approach, in which a road operator can allocate a road or a section of a road (a network element), taking into account the attributes listed above. It has to be noted that the Operating Environments are obtained through a qualitative and sequential approach, in order to make it simple and easy to use for any part of the road network.

The general layout (see Table 7) is defined according to a letter code relating to the different physical characteristics, following a slightly modified TELTEN approach (ERTICO, 1997[11])

— C for critical spots (bridges, tunnels, reversible lane sections, etc.)
— T for motorways
— R for roads other than motorways
— S for motorway corridors or networks
— N for road corridors or networks
— P for peri-urban road networks.

Table 7: **Operating environments for European ITS services**
(see also Annex C: Operating Environment Classification)

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	1		X			and	X	
	2		X			and		X
	3			X	X	and	X	
	4			X	X	and		X
Motorway corridor or network								
S	1			X		and		(X)
	2				X	and		(X)

11 ERTICO 1997. TELTEN2 Final Report. Road Transport Telematics for better traffic management in Europe. CD-ROM. Brussels, March 1997

Road corridor or network								
N	1			X		and		(X)
	2				X	and		(X)
Peri-urban motorway or road								
P	1			(X)	(X)	and		(X)

The Operating Environments can be used in a number of ways. Four frequent uses are described below.

- **Operating Environments and deployment priorities**: By describing the critical spots and the sections with most severe problems and concerns, the Operating Environments can be used in selection of the parts of the road network for improvement measures as well as for prioritising between the different road segments and connections when the road operator is implementing different measures. For Europe-level assessments it would be preferable to use a consistent methodology for classifying the European road network into Operating Environments as possible.
- **Operating Environments and Service Levels-tools for deployment planning**: Operating Environments can also be used to steer and harmonise the implementation of Core ITS Services by the road operators in order to achieve harmonised service composition and harmonised service levels within a certain Operating Environment. To achieve this, there needs to be a description per Core ITS Service on adequate service levels to be applied in different Operating Environments. In EU EIP, the Operating Environments were also shown to be applicable to describe the service levels of digital and communication infrastructures facilitating C-ITS services and automated driving.
- **Application of Operating Environments in Deployment Guidelines**: Operating Environments are used in the Deployment Guidelines in order to guide towards a harmonised service composition. The aim is to achieve consistent service levels related to the type of road section, corridor or network in a way understandable also to the road users.
- **Operating Environments in Strategy and Road Map processes**: By using the Operating Environments as the basis for the deployment strategies, road maps and action plans, rather than the physical road network, project partners can discuss deployment priorities in relation to an abstract network model, and then bring this information back into their national planning process. By adding the dimension of service level improvements and the dimension of time, the basic information required for an ITS deployment road map and action plan can be put in place.

The Level of Service criteria concept

In order to be able to match the road and traffic-related classification of environmental conditions with Levels of Service, a set of criteria is required according to which various service levels of ITS Core service deployments can be differentiated. These criteria provide - for each ITS Core service specifically - the so-called Level of Service criteria tables, which describe three levels of service A, B and C for all criteria. Service level category A describes a low level, level B a medium level, and level C a high service level category. Each Level of Service table provides a specific set of criteria tailored to the characteristics of the respective service. An example of such a Level of Service criteria table is provides in

Table 8: **Level of Service Criteria for the "Traffic management for corridors and networks" service**

Level of Service: Traffic Management for Corridors and Networks			
Core Criteria	**A**	**B**	**C**
Coverage	Critical spots coverage	Spatial expansion of the service, linkages	Total network coverage (all critical spots)
Availability to time	Service periodically ensured during critical periods	Extended availability, when required	Service 24/7 ensured
System* availability	One sole system available	Diverse systems	Diversity of systems: consistent information and traffic management measure support
Consistency	Consistent road user guidance at local level	Consistent road user guidance along the routes	Global consistency of road user information through any media along the route
European network approach	Knowledge and scenario sharing between neighbouring regions	Cross-border scenario consistency	Coordinated deployment of common measures, including conurbation areas
* Traffic control und guidance systems, event and traffic condition and travel time information systems			

The Level of Service Criteria to Operating Environment relation

Once the two basic concepts "*Operating Environment concept*" and "*Level of Service concept*" have been created, both concepts can be mapped to each other. The result is a so-called "*Level of Service to Operating Environment mapping table*", which depicts the minimum and optimum LoS which should be respected when the ITS-service is deployed. This is done for all ITS Core services in this handbook. Table 9 shows a Level of Service to Operating Environment mapping table using the example *Traffic management for corridors and networks service*. If we look for instance at the levels of services related to Availability in time, the lowest level of service A "*Service periodically ensured*" during critical periods is the minimum requirement (M) in all operating environments except for N2 and P1, where the minimum level is higher, B calling for extended availability in time when required. "The operating environment R1 is not expected to require the service, and therefore no requirements apply there. M marks the level of service that should be provided on all roads or road sections belonging to the specific operating environment. The level O denotes the optimal level of service, i.e. the level where the road operators should aim for in the long run. In the example, the O levels are higher than the M levels for motorways, four-lane roads, and networks with severe congestion problems i.e. for C1, T3, T4, S2 and N2. For other operating environments, the road operators do not need to reach for higher level of service than the minimum one, and thereby the marking OM is used to denote this. The highest level of service C Service "*24/7 ensured*" is to be aimed for only the road and motorway corridors and networks with severe congestion concerns, i.e. operating environments S2 and N2.

Table 9: **Level of Service to Operating Environment mapping table**

TRAFFIC MANAGEMENT FOR CORRIDORS AND NETWORKS			Operating Environment													
Criteria for the Level of Service			C1	T1	T2	T3	T4	R1	R2	R3	R4	S1	S2	N1	N2	P1
Coverage	C	Total network coverage (all critical spots on the network)										O	O	O	O	O
	B	Spatial expansion of the service, linkages			O	O	O		O	O	O		M		M	
	A	Critical spots coverage	OM	OM	M	M	M	NA	M	M	M	M		M		M
Availibility to time	C	Service 24/7 ensured											O		O	
	B	Extended availibility	O			O	O					O		O	M	OM
	A	Service periodically ensured during critical periods	M	OM	OM	M	M		OM	OM	OM	M	M	M		
System Availibility	C	Diversity of systems: consistent information and traffic management measure support										O		O		O
	B	Diverse systems	O		O	O	O		O	O	O		O		O	
	A	One sole system available	M	OM	M	M	M	NA	M	M	M	M	M	M	M	M
Consistency	C	Global consistency of road users information through any media along the routes										O	O	O	O	
	B	Consistent road user guidance along the routes														O
	A	Consistent local road user advice along routes	OM	OM	OM	OM	OM	NA	OM	OM	OM	M	M	M	M	M
Level of Coordination	C	Coordinated deployment of common measures, including conurbation areas														
	B	Cross-border scenario consistency		O	O	O	O					O	O	O	O	O
	A	Knowledge and scenario sharing between neighbouring regions	NA	M	M	M	M	NA	OM	OM	OM	M	M	M	M	M

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

2.7 The Level of Quality concept

The "Level of Quality" concept is used for Traffic and Travel Information services and reflects the requirements of data quality which are needed for the provision of those services. This concept is not end-user oriented as the Level of Service table (see above). Instead, the concept relates to data processes between the detection of road and traffic-related conditions, and the transmission of such data via National Access Points.

Definitions for data quality have been elaborated by EU EIP. In particular, frameworks have been developed to commonly describe and document quality in the context of different ITS data domains. The work has been related to the different data domains of ITS Directive 2010/40/EU and its corresponding Delegated Regulations.

These frameworks have been published as so-called Quality Packages, each mapping quality aspects to the various Delegated Regulations:

— Safety-related traffic information (SRTI) and Real-time traffic information (RTTI): Quality Package[12]

12 Kulmala, R. et al. (2019), "Quality Package for safety-related and real-time information services", Deliverable by EU EIP sub-activity 4.1, https://eip.its-platform.eu/highlights/update-eu-eip-quality-package-srti-and-rtti

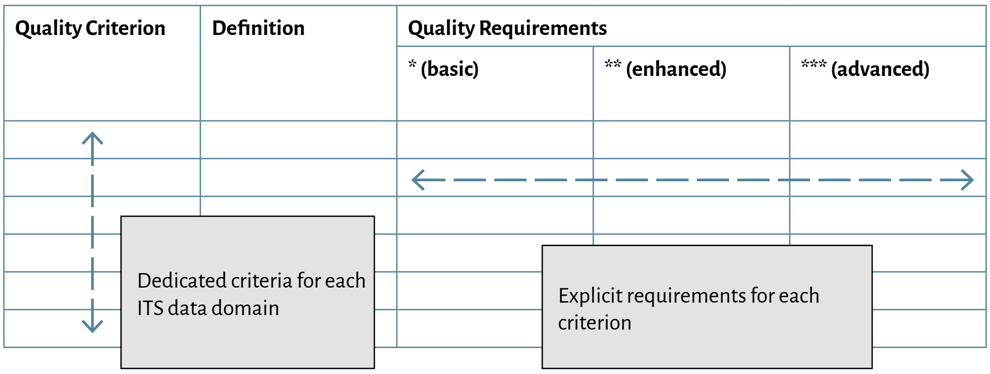
— Multimodal Travel Information Services (MMTIS): Quality Package[13]
— Intelligent Truck Parking Services (ITPS): Quality Package[14].

The Quality Packages contain quality-related definitions and concepts, as proposed and agreed by EU EIP partners for the use in Europe. Some of the Quality Packages have been validated since their initial publication, involving stakeholders and testing data qualities in real-world applications. Such validation resulted in improved and updated Quality Packages.

Each Quality Package contains the following elements:
— A set of quality criteria in the categories 'Level of Service" (describing the provision of data) and 'Level of Quality" (describing the data as such)
— Specific quality requirements to be met for individual Traveller Information services
— A set of proposed quality assessment methods.

The quality definitions are laid out in a tabular format in each Quality Package, as illustrated in Table 10.

Table 10: **Layout of quality definitions in each Quality package**



This way, dedicated quality criteria are introduced and defined for each ITS data domain, and populated with explicit requirements (staged in three levels "basic", "enhanced" and "advanced").

Table 11: **Quality definition table (example)**

Quality Criterion	**Definition**	**Quality Requirements**		
		*** (basic)**	**** (enhanced)**	***** (advanced)**
Timeliness (start)	The time between the occurrence of an event and the acceptance of the event	Best effort	For 95 % of all events: Acceptance after first detection < 10 min	For 95 % of all events: Detection & acceptance < 5 min after event occurrence

For more details: web links with more explanations and download options for the Quality Packages are referenced above.

13 Niculescu, M., Jansen, M., Barr, J., Lubrich, P. (2019): Multimodal Travel Information Services (MMTIS): Quality Package, Deliverable by EU EIP sub-activity 4.1, https://eip.its-platform.eu/highlights/multimodal-travel-information-services-mmtis-update-quality-framework
14 Milea, R.D., Vaduva, F.C., Niculescu, M., Lubrich, P. (2019): Intelligent Truck Parking Services (ITPS): Quality package, Deliverable by EU EIP sub-activity 4.1, https://eip.its-platform.eu/highlights/intelligent-truck-parking-services-itps-quality-framework-published

3
TTIS - Traffic and Travel Information services

3 TTIS - Traffic and Travel Information services

3.1 TTIS-Introduction

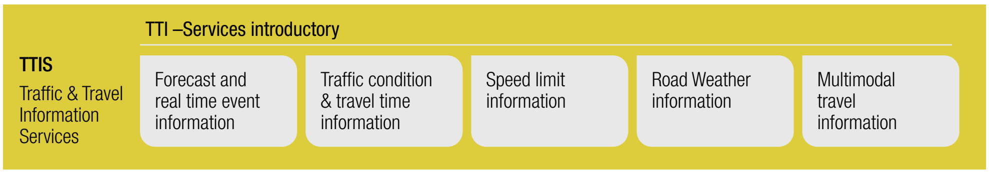
3.1.1 Overview

This introductory provides an overview of the structure of Traffic and Travel Information Services and describes aspects, which are common to all services from the whole spectrum of Traffic and Travel Information services. This introduction has been prepared to avoid repetition in the specific descriptions of the Travel and Travel Information services.

As shown in Figure 10, the set of TTI services comprises five different ITS Cores services:

- TTIS-01 Forecast and Real-time Event Information
- TTIS-02 Traffic Condition and Travel Time Information
- TTIS-03 Speed Limit Information
- TTIS-04 Road Weather Information
- TTIS-05 Multimodal Travel Information

Figure 10: **TTIS - Traffic and Travel Information Services**



In the following sections, the profile and other important aspects of Traffic and Travel Information services are discussed in more detail:

- Purpose and scope of Traffic and Travel information services
- Vison, Missions and Benefit of TTI Core services
- Key actors in the traffic and travel information value chain
- Conditions for service provision – new business models
- Service provision

3.1.2 Purpose and scope of Traffic and Travel Information services

All road users and travellers need accurate, integrated and comprehensive traffic and travel information in planning decisions and to be able to respond to disturbances that might occur during travel. By modifying behaviour, traffic and travel information services support the road operators' task.

Uncertainty over journey and arrival times is a major problem, as travellers and road users expect consistently reliable information to help make well informed travel decisions.

The generation of traffic and travel information is a broad concept that cuts across the entire field of operations and covers several areas:

— regular information gathered from operational partners
— providing users with information on predicted conditions (before trip) or current conditions (on trip)
— road and traffic information as an important element for public transport, freight and fleet management operator**s**

To be able to inform all partners, drivers and other travellers effectively, operators and service providers must define information channels that should be coherent with the operation and management plans.

It is important to distinguish the difference between traffic and travel information:

— **Traffic information** - concerns the conditions of traffic and on the road and can include forecast as well as real-time information. More detailed forms of information include hazard messages or incident warning and control support information such as notice of road obstructions, lane control, or speed control.
— **Travel information** – is related to information or advice on the transport system status. Road users are free to decide for themselves if and how to react to the information or advice. In a multimodal setting, this may include public transport timetables. Travel information can be provided before and during the trip to facilitate travel planning, booking and adaptation to possible incidents.

Each ITS Traffic and Travel Information service has a distinct scope, and in many cases, a direct link to events, conditions and data categories listed in the Delegated Regulations of the EU ITS Action Plan and Directive.

TTIS-01 Forecast and Real-time Event Information

"Forecast and Real-time Event Information" covers the provision of information about both expected and unexpected events to road users on identified road segments of the network and its interfaces.

Events are defined as abnormal situations, which may lead to adverse effects on the road with regards to traffic safety, efficiency and the environment. There are two categories of events:

— **expected events -** these are planned or anticipated events, including planned road works, recurring traffic jams, closures, strikes, protest rallies, major events (sports games, concerts, festivals), and frequent network overloading (commuter and holiday travel), parking rest area information, road/bridge/tunnel/lane/border closures.
— **unexpected events –** including incidents, accidents, road/bridge/tunnel/lane closures, objects on the road (objects, animals, people), ghost-drivers, sudden end of queue due to slow or stationary traffic, reduced vision, slippery road surface (due to e.g. aquaplaning, ice, oil), exceptional delays at borders.

This service includes specific events, conditions and traffic data categories listed in Delegated Regulation for road safety-related minimum universal traffic information service (EU) No 886/2013, and real-time traffic information services (EU) No 2015/962.

TTIS-02 Traffic Condition and Travel Time Information

"Traffic Condition and Travel Time Information" covers the provision of information on the traffic conditions (Level of Service) and travel times on identified road segments of the network.

Traffic Condition / Level of service (LoS) is a qualitative measure used to relate the quality of traffic service. LoS is used to analyse road networks by categorising traffic flow and assigning quality levels of traffic based on performance measure such as speed, volume, delay etc. This is typically based on the continuity of flow. Traffic condition information aims to improve general conditions of network use. Its general aim is safety and user comfort.

Travel time is the total elapsed time necessary for a vehicle to travel from one point to another over a specified route under existing traffic conditions.

As the volume of traffic approaches a point of exceeding capacity, LoS falls, and traffic is characterised by stop-and-go waves, longer travel times, low driver comfort, and increased accident exposure.

This predictive or real-time information can be provided both on-trip and pre-trip.

This service includes specific traffic data categories listed in the delegated regulation for real-time traffic information services (EU) No 2015/962.

TTIS-03 Speed Limit Information

Drivers should always drive at an appropriate and safe speed. “Speed Limit Information” services are implemented to help ensure that the driver always and everywhere knows what the speed limit in force is. Speed limits can be static or dynamic; both can be included in information services, and can be provided to drivers via road signage, road markings and in-vehicle systems.

Under national legislative frameworks, road and traffic authorities have to install and maintain prescribed speed limit signs on their roads. Data about speed limit signs is generally maintained as part of an asset register and can contribute to a static speed limit database.

Dynamic speed limits commonly take into account the real-time traffic, road and weather conditions, better reflecting a safe speed. These are controlled via traffic control systems.

This service includes specific traffic data categories listed in the delegated regulation for real-time traffic information services EU No 886/2013 and (EU) No 2015/962.

TTIS-04 Road Weather Information

“Road weather information” covers conditions of the road surface, visibility conditions and infrastructure specific information on parts of the network such as bridges, which can be adversely affected by high wind conditions. The provision of dynamic weather information covers both weather information and weather warnings, such as those on exceptional weather conditions.

The intention of the service is to enable different user groups (e.g. car drivers, HGV drivers, public transport users) to react and to adapt their behaviour to the weather conditions they are going to meet, by informing them about the current and the expected development of weather conditions.

When service providers use data regarding the road weather conditions provided by road authorities and road operators, they should take into account, as far as possible, any temporary traffic management measures taken by the competent authorities.

This service includes specific events, conditions and traffic data categories listed in the delegated regulations for road safety-related minimum universal traffic information service (EU) No 886/2013, and real-time traffic information services (EU) No 2015/962.

TTIS-05 Multimodal Travel Information

"Multimodal Travel Information" is comparative information of different modes/means of transport and/or the combination of different modes/means of transport within the same route. The service offer information for at least public transport, private car transport and usually pedestrian and bicycle transport.

Multimodal travel information services require data from the different transport modes such as road, rail, water- and airborne transport, walking, cycling and additional services such as parking.

This service includes specific data categories listed in the Delegated Regulation for multimodal travel information services (EU) No 2017/1926.

3.1.3 Vision, Missions and Benefit of TTI Core services

3.1.3.1 What is the Vision?

The main objective of providing travel and traffic information, including safety-related & real-time traffic Information to the road user is improving the safety and the efficiency of the network supporting current traffic management activities and traffic management plans. This includes both pre- and on-trip information and gives road users a better driving experience (i.e. they can plan with confidence, adapt trips, stress is reduced, lost time is reduced).

Expected and unexpected events can develop into a traffic bottleneck, due to abrupt reactions of uninformed drivers. However, if those drivers know the upcoming traffic situation in advance they would be prepared and could pro-actively adapt their speed and following distance, thus preserving smooth, stable and safe traffic flow.

Real-Time Traffic and Travel Information services allow traffic information to be factored into both pre- and on-trip journey planning. This can alter the departure times, assist the driver to take more effective routing decisions or even alter the decision to travel.

The provision of information to drivers enhances the travelling experience even if the information does not directly impact on network efficiency or safety. Better-informed drivers tend to be calmer and hence more concentrated. Other impacts can be the increased mode share of public transport, when drivers decided to select another mode of transport for their trip and reduced air pollution.

Note: As the handbook draws from the perspective and expertise of road operators, the focus of all ITS Core services is on road transport and inter-urban road network. In this context, the MMTIS Core service vision and mission is centred mostly towards the services and data categories from the DR that are connected to road transport outside urban environments.

3.1.3.2 What are the Missions?

The main service mission is to inform about expected or unexpected events in order to support the user in finding the best way to travel and to do so in a calmer and safer way and provide accurate and timely information on traffic conditions and travel times to support travellers in making appropriate and safe trip choices.

This predictive or real-time information could be provided on-trip and pre-trip using different information channels, accessible or receivable by the user via different end-user devices. The service may comprise common information as well as individual (personalised, on-demand) information.

Problems to consider:

- different organisational and technical conditions among traffic managers, road operators, transport operators and service providers for the dissemination of information
  - take into account the individual backgrounds and requirements of each partner
  - promote dialogue between traffic operators along corridors for homogenous way of dissemination of information
- diverging interpretation of the infrastructure by the road users
  - communication to the road user as far as possible through clear and mono-interpretable pictorial signs. Use of language only as explanation for the signs used
- diversity of information portable with different presentation including on board system
  - promote use of common criteria for presenting information (i.e.: common color for level of service)
- Incompleteness of information
- Timeliness of information
- Uncertainty of any prediction
- Inconsistency in the presentation of information to the road user, across different information channels and portals (diverging interpretation of the information by the road user). To offer high-quality individual (personalised, on-demand) information, the co-operation with public bodies and private commercial partners/service providers is crucial. More information on new models of cooperation between public and private partners can be found in chapter 4.1.4.2
- Inconsistency of the information provided with traffic management plans (TMPs, see TMS-07) which are in operation of the road authorities or traffic management centres
- With respect to an actual change of travel behaviour and an alternative choice of traffic mode or travel route, the pre-trip travel planning via navigation systems or route planners must be completed by a forecast of traffic conditions which may not be possible to deduce just from historical data. Here the municipalities and the regions can give essential information about planned traffic-related construction or even significant events. This locally available expertise is necessary because no traffic relevance can be derived from the mere fact that an event takes place. Experience of the visitor behaviour and corresponding traffic streams should be considered.

3.1.3.3 What is the contribution of TTI Core services to overarching European ITS objectives?

3.1.3.3.1 Summary

Numerous evaluations of traffic and travel information and particularly warning services deployments in the EasyWay project and subsequent ITS European corridor projects have shown that they can have a positive impact on traffic safety (up to 11% fewer accidents with injuries in bad weather conditions), mobility (up to 20% shorter travel times) and the environment (up to 10% less energy consumption with corresponding effects on CO_2 emissions).

When displayed before the journey (e.g. internet, travel time forecasts), the impact of Traffic and Travel Information services on safety and congestion is lower (up to 2% less congestion), but the provision of multimodal information to encourage modal shift could lead to an overall reduction in CO_2 emissions.

Safety

Travel information has three primary impacts in increasing road safety.

The first is largely theoretical. It assumes that an increase in mode share for public transport can be achieved through high quality pre-trip and multimodal travel information. The reduction in traffic levels on the road in turn has a positive impact on safety by reducing the number of accidents and managing demand on the road asset particularly at peak times. It is also generally accepted that travelling by public transport is inherently safer than travelling by car. It is stated that the public are up to 10 times more likely to be involved in an accident travelling by car than by public transport.

A more direct impact of traveller information, although still difficult to quantify, assumes the timely provision of on-trip travel information reduces accident rates. For example, informing drivers of extreme weather conditions or current traffic conditions ahead of their travel can increase drivers' awareness and therefore reduce accident rates.

Information which principally addresses the efficiency of driving such as travel time information also has an indirect safety effect as informed travel leads to less risky driving behaviour. Past TTIS studies have revealed that travellers value timely information on the traffic conditions and that real-time traffic information reduces travel uncertainty and the stress due to uncertainties.

Network Efficiency

In a similar manner to safety, supporting increased modal shift toward other modes including rail and public transport requires good quality pre-trip and multimodal travel information. This allows for more efficient pre-trip routing decisions and/or departure times; thus, increasing network efficiency and improving asset efficiency. On-trip information related to current road conditions (i.e. travel time, weather status/ warnings) should have a positive impact on network efficiency as drivers should use this information to make more effective travel decisions. It should be possible for well-informed travellers who improve their choice of mode, route and departure time to contribute to a more even spread of traffic throughout the day. It can be assumed that:

— making information services work well under incident conditions is likely to be cost effective
— providing travellers with information as early as possible is likely to increase its effectiveness in terms of behavioural adaptation.

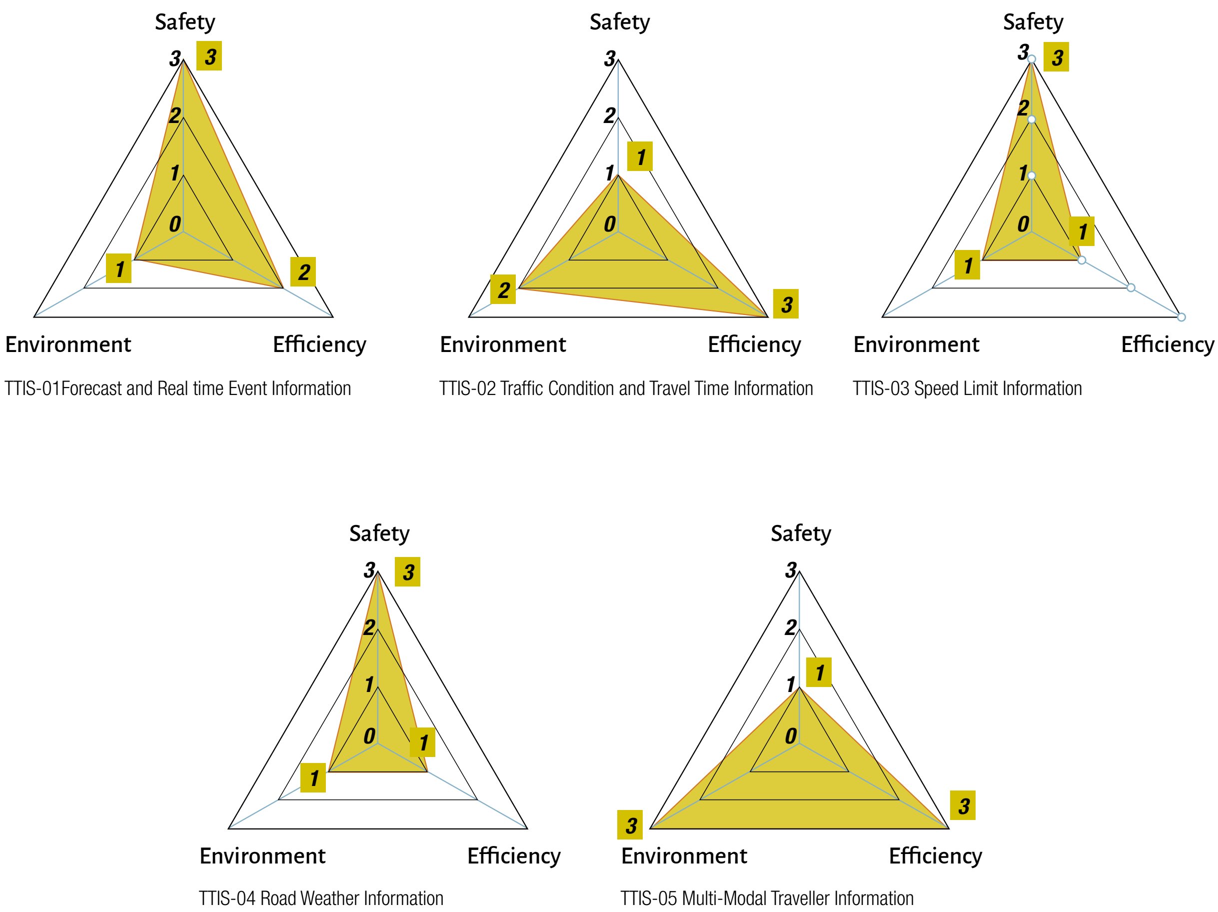
Environmental Impact

The positive environmental impact of travel information is primarily tied to the increase in network efficiency noted above. So, for example, avoiding stationary or slow-moving traffic will reduce congestion and therefore emissions of CO_2 and other air pollutants. More recent research[15,16] also indicates that where such information is available the more environmentally conscious traveller may, by comparing the impact of their vehicle journey with public transport alternatives, opt for the most environmentally friendly journey choice. Furthermore, keeping the environmentally aware driver informed "on trip" of environmentally sensitive areas and linking this with suggested speed control may promote better compliance with the variable speed limit. In France, it is common to reduce the general speed limit by 20 or 30 km/h on a temporary basis with the aim to reduce air pollution and smog.

15 Institute for Road Safety Research (SWOV), 2019. „Coaches and road safety in Europe; An indication based on available data 2007-2016". https://www.swov.nl/publicatie/coaches-and-road-safety-europe
16 Victoria Transport Policy Institute (VTPI), 2020. „Safer Than You Think! Revising the Transit Safety Narrative". https://www.vtpi.org/safer.pdf

Travel and Traffic Information Services Radar Diagrams

Figure 11: **TTI Core services radar diagrams**



As shown in the radar diagrams (see Figure 11), the main benefits delivered by TTI Core services relate to safety and efficiency which are priorities of overarching European ITS objectives of road operators. Thus, by providing road users with high quality, accessible travel and traffic information benefits can be gained on existing networks without deploying significant additional infrastructure.

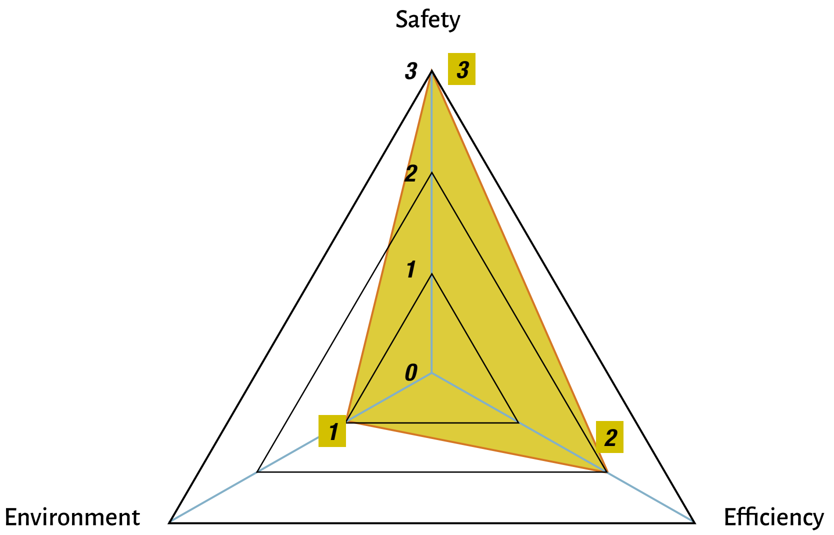
In the following section, the specific effects of the Traffic and Travel Information Core Services described in this handbook are discussed in more detail.

Note: As already mentioned in chapter 2.3, the Service Radars of the various services are not in relation to each other and not directly comparable.

3.1.3.3.2 ITS service radars in detail

Forecast and Real-time Event information

Figure 12: **Service radar "Forecast and Real-time Event information"**



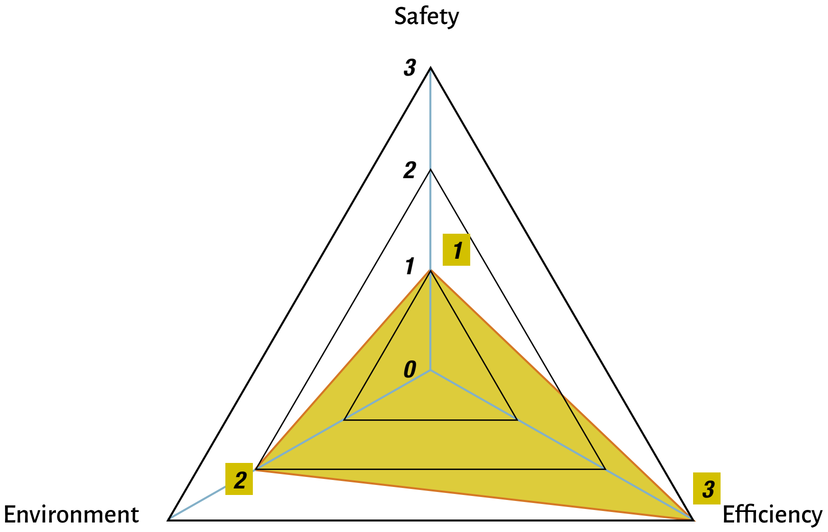
Safety
Information on events can help prevent accidents by warning drivers of dangerous situations, especially for unexpected events related to dangerous situations (flooding, ice …).

Environmental impact
It is commonly accepted that this type of information may lead to more efficient network use and in particular support greater use of public transport and by doing so reduce emissions.

Network efficiency
More informed travel decisions (route choice, mode choice, time of travel) and reduction of congestion are expected as a result of the provision of event information.

Traffic Condition and Travel Time Information

Figure 13: **Service radar "Traffic Condition and Travel Time information"**



Safety

Providing LoS and travel time information provides predictability to road users, they feel more in control of their journey and can estimate their arrival times more accurately. More reliable and predictable trips are safer. If this information is missing drivers can feel frustrated, and may take more risks.

Environmental impact

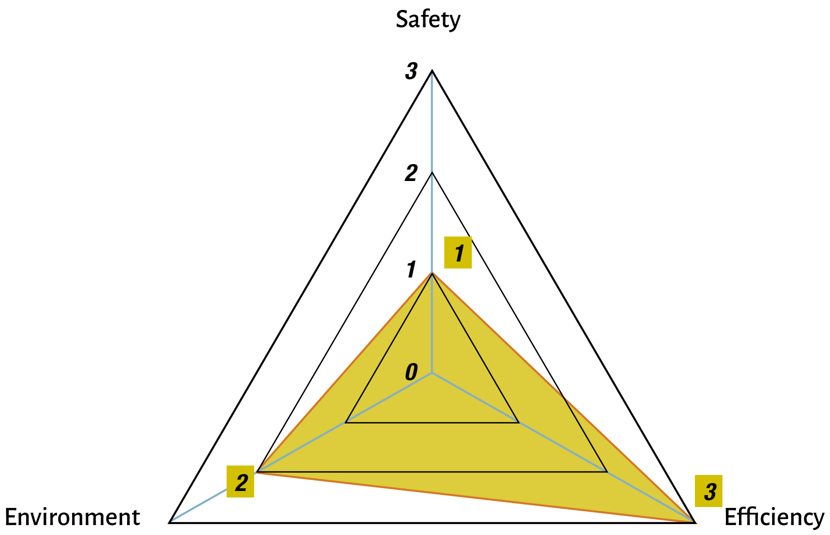
When drivers are aware of current traffic LoS and expected travel times, they drive more smoothly and consistently and choose more efficient routes. This way, environmental benefits are achieved through reductions in noise, traffic emissions and fuel consumption.

Network efficiency

By providing accurate travel time information drivers can plan their journey times more realistically and make more accurate arrival time updates while on the road. Drivers may re-route or alter their departure times based on this information. With drivers having an appreciation of LoS and travel times, they can utilise the network more efficiently, and for road operators confirmation of good LoS and journey time reliability informs them that the network is performing well.

Speed Limit Information

Figure 14: **Service radar "Speed Limit Information"**



Safety

Research has shown that speed is a major contributory factor in around 10% of all accidents and 30% of all fatal accidents (TRB, 1998; OECD, 2006). With higher speeds, the accident risk is higher and more severe accidents more likely (Aarts & Van Schagen, 2006). Managing speed is therefore the most important measure to reduce road deaths and injuries. Potential benefits expected for Speed Limit Information systems is around 3.5% of all road user fatalities (Wilkie and Tate (2003), Carston and Tate (2005)).

Environmental impact

High speeds and large speed variations also increase exhaust emissions, traffic noise and fuel consumption (EC, Speed and Speed Management (2018)).

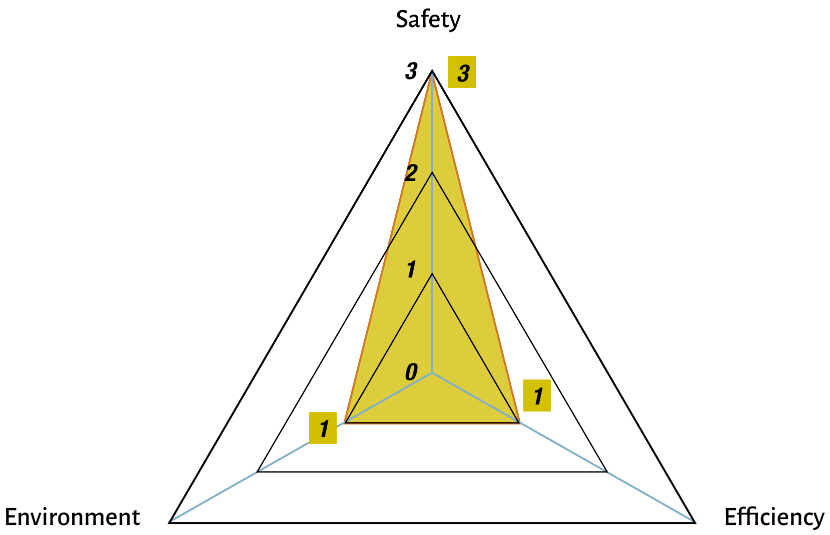
Network efficiency

Although in principle higher speeds can reduce travel times, it leads to more road accidents and is a major cause of congestion. Also, with shorter journeys the time gained is marginal. (EC, Speed and Speed Management (2018)).

To effectively manage speed and mitigate against negative impacts, an integrated combination of appropriate measures is required. Speed Limit Information is a tool to help manage safe speeds; it can be deployed in various ITS applications to support drivers in their task of speed control i.e. to drive within speed limits, or below the limit where appropriate.

Road Weather Information

Figure 15: **Service-Radar "Road Weather Information"**



Safety

The provision of weather-related information to the different user groups (e.g. travellers, dispatchers and operators) significantly contributes to increased road safety as the drivers can be warned in advance of an adverse weather situation.

Also, useful information for drivers who are in transit is real-time, site specific information on visibility and road meteorological conditions.

Environmental impact

Being informed in advance regarding extreme weather conditions, renouncing to use the car when it is possible, the travellers could avoid causing CO_2- and noise-pollution and/or could save fuel resources by lowering fuel consumption and so on.

Also, by changing the route due to the unfavourable weather conditions congestions can be avoided, creating benefits for the environment through reduction of the impact of associated air pollution whilst vehicles are at a standstill.

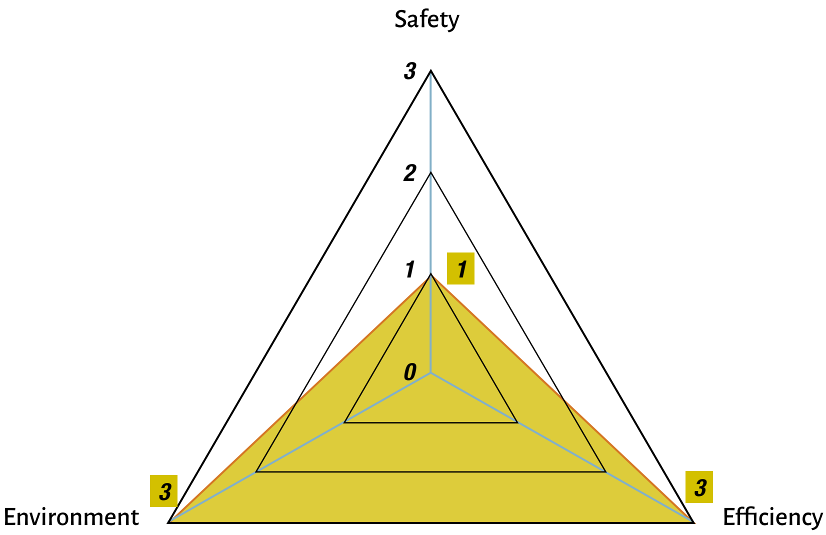
Network efficiency

Same as for other ITS services, road weather monitoring itself does not provide any monetised benefits unless it is combined with information services such as weather centres and information systems. Major benefits by establishing a weather information service include:

— Improving motorists' travel time and safety
— Reducing operators' costs by supporting the dispatching activities for snow ploughs and de-icers (saving costs for fuel, labour as well as salt; reducing annual vehicle costs).

Multimodal Travel Information

Figure 16: **Service-Radar "Multimodal Travel Information"**



Safety
The safety impact of multimodal services is mainly a result of the increase of network efficiency accompanied by improved traffic flows and reduction of possibly hazardous traffic situations (e.g. congestion). The safety impact is not a direct goal of multimodal services but rather an indirect result of the two other radar impacts of environment and efficiency. Therefore, the radar peak for safety is lower than for the others.

Environmental impact
Due to the mode/means of transport comprehensive and also comparative information provision, multimodal travel information services can foster a modal shift towards more environmentally-friendly modes/means of transport. Therefore, the service radar shows a full peak for (positive) environmental impact.

Network efficiency
As it was argued for environmental impact, the same can be applied in terms of network efficiency: multimodal services can optimize the usage of the whole transport network due to information provision for different modes/means of transport whereas the user can choose the most suitable route.

3.1.4 Key actors in the Traffic and Travel Information value chain

3.1.4.1 Introduction

It should be noted that the value chain shown and described in this document is based on the TISA Value Chain model[17]; this is not meant to be prescriptive as there are many other examples of TTIS value chains with all essentially describing similar actors and processes, but with differences in emphasis and allocation of functions reflecting national practices and other business models.

There are several key actors in the value chain in providing dynamic traffic and travel information services:

— The source of all information services is a content owner or **content provider** who owns the content (e.g. traffic data) and/or provides the content for a service application.

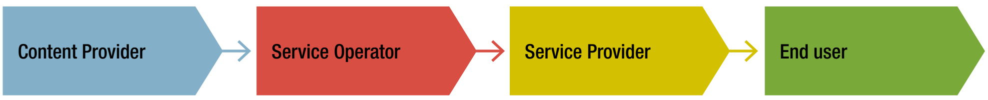
— A **service operator** who uses this content to generate information with added value. The information then forms part of a service and covers not only the adaptation of the original data but also the visualisation of the information (e.g. the creation of a thematic map).

— The **service provider** are the interface to the customer. Service providers publish the service and are responsible for all marketing and contractual issues with the end user.

— The **end user** is the consumer of the information service.

This relationships chain is illustrated in Figure 17. The following paragraphs give more detail on each of these players and their functions and characteristics. It should be noted that the precise roles and position of actors is not the same in all situations; this depends on national and regional TTIS organisational structure and business case.

Figure 17: **Value chain for Traffic and Travel Information services**



3.1.4.2 Content provider

The content provider is the first node in the value chain and therefore in most cases also the content owner, i.e. the institution that collects the data ("raw data" without any data refinement - meaning without generation of additional value) and controls rights to use and distribute the data. The content provider collects and administers the data (e.g. traffic data on traffic volume and velocity are collected by traffic control centres not primarily for use by traffic information services but for the operation of traffic control systems). However, this data has value in traveller information systems e.g. in indicating journey time information and in traffic management.

It is important to distinguish between the role of public/free content providers that collect data (primarily for internal use) and who provide it for the use in public or private/commercial information services and private/commercial content providers whose business is to collect data, to organize them into the form required by their clients and to sell the data to service operators.

17 https://tisa.org/assets/Uploads/Public/EO12013TISADefinition-ITS-value-chain20121018.pdf

Examples of different public and private content providers are: national, regional or local road authorities, police, commercial traffic data provider, commercial traffic information provider, toll system operators, parking facilities operators, public transport operators, automobile clubs, private road operators, private address and POI data provider, weather services, map agencies, commercial map enterprises, mobile/cellular phone operators.

There are also alternative models where it is the end user who is increasingly performing the role of content provider (such as the free editable map website OpenStreetMap: www.openstreetmap.org). In this model the information sources are often working on the premise of building a user generated consensus of a situation to provide information which is effectively then verified by the network users.

If content providers carry out additional data processing tasks such as forecasting or the generation of a thematic map based on that raw data, the content provider can then become a service operator (even if this is a very basic service). The commercial interest of the content provider is to sell and distribute the information within the relevant TTIS business area (i.e. satellite navigation content). Public content providers are not normally motivated by commercial interest but rather because they want to drive forward domestic or European wide policy objectives in relation to reduction of congestion, improved safety, supporting modal shift or environmental objectives.

3.1.4.3 Service operator

Typically, the service operator uses raw data from the content provider and then refines the data to generate useful traveller information. The refinement of raw data can be done by applying different methodologies such as data fusion with data from other data sources or by using an algorithm and historic data for a more refined result.

The raw data provided by the content provider does not have any practical use to the end user. The service operator generates information services for different service providers and different end user devices, e.g. websites or smart phones. An animation or a thematic map with the same content can be generated in different ways for different service providers (corporate identity) or different end user devices (different technology platforms). There are many different service operator models.

Additionally, service operators can provide a clearing functionality to support the interoperability of different services, i.e. to act as a central hub for the collection and distribution of information. Other actors of the value chain can also provide this functionality.

3.1.4.4 Service provider

The service provider is the organisation/actor that provides the direct interface to the end user with the purpose of providing services including traffic information. The service provider could be a private company or a public institution such as a local road administration or traffic information centres enabling and providing a service to either a narrow target group or a broad range of users. This could be done within the current business or as an extension of a current company or as a new enterprise.

Service providers offer the information service to their customers and have to operate all functions related to the customers such as billing, customer administration or marketing. In most cases, the service provider is acting as service operator too. This means that they use data from a content provider, process the data to generate information and provide this information to the end user. Sometimes the service provider uses a service that is operated by another service operator (e.g. many providers of internet portal services offer a routing service that is operated by a service operator such as map24: http://www.map24.com); or integrates other third party information e.g. public transport information to provide a more complete service.

If the information service provided to the end user is not free of charge, the service provider has to administrate customer billing, or to absorb these costs. Furthermore, if the service provider uses content and external services that have commercial costs, it has to pay the charge for the use of content and services to the particular content provider or service operator.

The service provider may have a commercial interest in providing packaged and filtered information to a group of target users through a service. Public service providers have often the non-commercial interest in supplying information services to citizens for free to advance wider public policy objectives, i.e. supporting modal shift, managing network demand, improve safety, reducing the impact of transport emissions on the environment.

In most cases the basic services are provided over the internet via web information services or smart phone apps (accessed by end users using the pull mode). Sometimes, information services are also provided using the push mode after subscription by the users. This may provide general access to information or personalised information (configured by users to the routes they use regularly).

3.1.4.5 End user

The end user is the customer of the service provider. End users are interested in getting timely information so that they can travel safely to their destination in the shortest distance or journey time with the least obstacles or disruptions. One major objective is that the end user without a private car should feel oneself as comfortable in the transport system as the one with the private car. The use of the information can be for private or business use. The role of information as defined is to:

- inform the individual of travel options,
- empower the individual to make fully informed choices and
- assist the individual to successfully undertake and complete the journey by getting timely updates which allow to her/him be aware and if practical to take avoiding action.

Increasingly, end users are motivated to make travel choices by the option which has the least detrimental impact environmentally. By making users aware of the carbon or emissions savings of certain modes against others for individual trips they may alter their travel choices.

End users have a variety of needs affecting their travel which should be met to allow them to complete their journey e.g. at a lower cost, or the ability to select the most time effective/convenient journey. In order to select the lowest cost or the fastest trip, they need relevant information. When dealing with the harmonisation aspects of the service, operators should keep in mind that services (and their harmonisation) should not distract the driver.

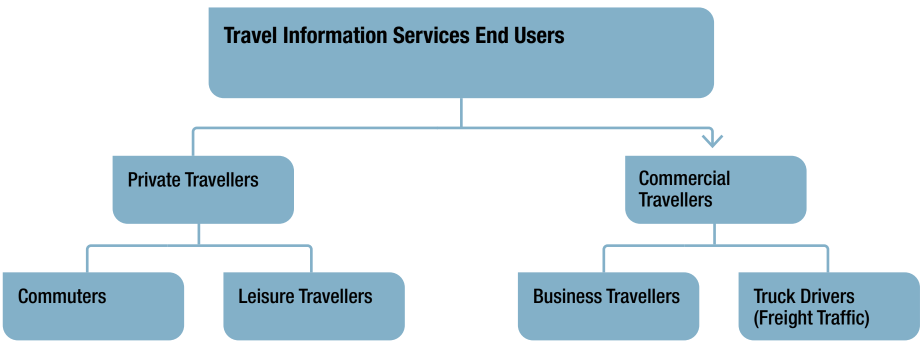
Furthermore, providers should design services around user needs. It is recommended using formats and technology platforms which are most accessible to widest number of users. Information provided to end users needs to deliver **what** the consumers want, **when** they want it and at the location **where** they are. Unless the perceived benefits of access to information exceed the perceived costs, users will not consult or regularly use the information service. The cost of a trip is comprised of features such as:

— financial cost (i.e. fuel cost, tolls/RUC costs, public transport charges, information access cost),
— time to be spent travelling.
— perceived comfort,
— perceived reliability,
— familiarity and
— safety/security during travel.

The end users expect a user-friendly system with a self-explanatory interface. The end user may not always want all the rich content available from a traveller information service but may only require those elements which affect the journey he/she is planning to make e.g. travel time delays, road incidents etc.. This requires a facility which allows the user to select the characteristics of this travel information. Regular consumers of the same service may prefer to create a personal user profile in order to reduce the input procedure; the user then receives a personalised service tailored to his/her needs. In the case of smart phones, the device may use its positioning functionality to identify the user's location and then provides information relevant to that location. While the user gives some personal data, he expects that privacy is guaranteed.

However, end users are not a homogeneous group, and their needs will be dependent on their personal requirements and the nature of their trip. User needs may be determined by User Type; Key Function, User Position/Journey Stage and Travel Type and may be based on the way travellers use information. When undertaking detailed analysis other groups with special requirements should also be considered such as the elderly, people with reduced mobility, visually impaired, young people and those travelling with children. The schematic, Figure 18, illustrates a simplified breakdown of TIS end users. There are, naturally, many different ways to categorise end users:

Figure 18: **Travel Information Services End Users**



— **Private Traveller**: Private travellers travel for private purposes.
  - **Commuter**: Commuters travel regularly to/from their workplace. They normally take the same route and travel mode each time and the trip is mostly limited to a regional extent.
  - **Leisure Traveller**: Leisure travellers can be defined as people who travel only during leisure time and not for business purpose. These can be long distance tourists or people carrying out short day-to-day domestic trips (shopping, hobbies, school run etc).

— **Commercial Traveller**: Commercial travellers travel for commercial purposes.
  - **Business traveller:** Business travellers travel for commercial purposes.
  - **Truck Drivers (Freight Traffic)**: Truck drivers manage the transportation of goods from one place to another. This includes local and long-distance distribution.

Based on the above mentioned points, an example of a value chain in practice is shown in Figure 19.

Figure 19: **Travel Time Value Chain Example**

3.1.5 Conditions for Service Provision – Business Model

For the entire supply chain of traffic and travel information, the European Traffic and Travel Information core services can be deemed to have contributions from four main actors that were already mentioned in the chapter 3.1.4.

Presently the roles outlined above (with the exception of the end user) are undertaken by different parties e.g. national and local authorities, either directly or through additional agreements with e.g. road operators, or by private industry when there is a business case for the development of such a service. These roles are normally governed by the following conditions:

— National authorities (or the entitled entity) provide information when:
  - there is an obligation on society to provide this information,
  - provision contributes to policy goals,
  - there is existing market failure to be addressed.

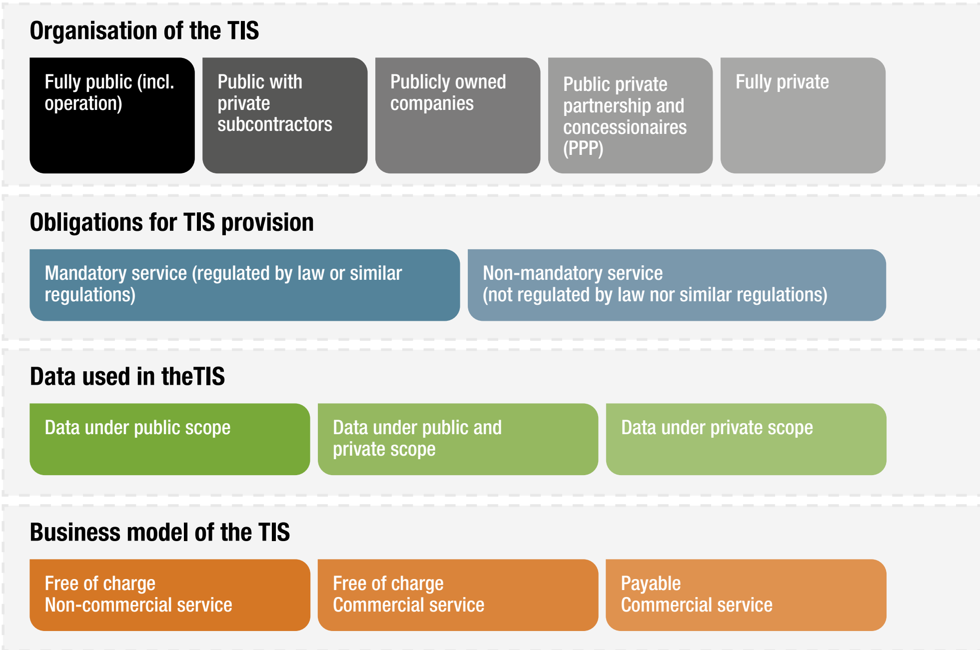
— Private industry provides information when a successful business model exists.

— Start-ups, where they see a chance to develop a business.

Because of the diverse nature and large differences between national policies on traffic and travel information, it is not possible to define which roles industry and national authorities will perform across Europe. Expectation is that business models will evolve to reflect market conditions and the prevailing circumstances of the market in individual member states. However, it is possible to define the different roles noted above. When a service is delivered by a member state, service continuity to users achieved through harmonisation should be the primary objective.

Figure 20 provides an example of the different models that can be applied to TTIS, moving from mandatory, public, free of charge services on the left to private paid commercial services on the right:

Figure 20: **Structures for TTIS Service Provision**



- **Organisation:** For each of the five models from A.1 to A.5, the entity directly providing the service will be either private or public. However, for some models, the responsibility for the performance of the service is not clearly separated between private and public. For example in A.2 the provider is private but it acts according to its contract with the public entity.
- **Obligation**: A more direct impact of traffic and travel information, although still difficult to quantify, assumes the timely provision of on-trip information reduces accident rates. For example, informing drivers of extreme weather conditions or current traffic conditions. An example of non-mandatory service could be the availability of commercial road side services.
- **Data**: TTIS can consist of various different data sources. Data can be distinguished between that under public scope (C.1) which might be operated by private companies but on behalf of public, data under the public and private scope such as data collected by the private sector, commissioned by the public sector (C.2), and data under private scope (C.3)
- **Business Model:** As most services consist of providing information only, it has so far proved to be difficult to create a business model for private service provision. However, it is possible that this situation might change and create a market for value-added services run by private **operators**. In any case, there likely is be a basic service available free of charge. A service such as traffic on Google maps is an example of a Free of Charge Commercial Service.

Therefore, it is recommended that the individual public authorities / service providers review how their existing information provision compares with the recommended service levels outlined elsewhere in the Reference Handbook and how that might best be organised to deliver the requirements of harmonised traveller information deployment. It will be particularly important for national authorities to undertake such a review when they are working in cooperation with neighbouring authorities to ensure that interoperability is achieved to comply with the proposed pan-European element of these services. More options of public/private partnerships are described in chapter 4.1.4.2

It will be necessary to develop innovative and flexible practises and agreements, which prove the business case for both national authorities and private actors. For example, data sharing agreements can contain real-time traffic information from in-car devices to the public sector in exchange for quality-assured traffic management data to the car device stakeholders.

The need to harmonise these services is also vital to ensure that regardless of whether the three key roles (content providers; service operators; service providers) are filled by private industry or public authorities the quality, content and timeliness of information is similar within the same operating environments across the Europe. Thereby harmonised traveller information comes to be expected by end users.

In some countries private service providers sell information to road operators. Quality regulations should be taken into account. End users should not pay again for the same service. By entering to data sharing agreements public bodies and private data/service providers have greater control over the way their data is managed and presented to the end user.

3.1.5.1 Levels of Quality

The data quality aspect is also vital for specification in terms of the levels of service as they are intrinsically linked. The ability for a traffic and travel information provider to reach the levels of service recommended within this handbook for TTI services is dependent on a level of data quality being reached.

An example of different data requirements is found when comparing the optimum level of traffic speed data packets required for travel time information which may be as small as 1 minute, with that for traffic condition information data, and that of planned events where it is unlikely data will be required to be updated as frequently.

The tables within the description for TTI services outline recommendations for the most important aspects of the Levels of Service and the Levels of Quality for the data “backbone” for each traffic and travel information service. It is believed that progress through these levels will lead to harmonised deployment of traveller information services. The need for a requirement to progress to the next level is inherent in the philosophy of deployment towards harmonisation although progress “up” these levels towards more harmonised services should only be undertaken if deemed necessary by the implementation body.

The tables within the TTI services descriptions also provide the recommended levels of service which deployment should strive towards the future. However, progress beyond these levels is still important when the requirement exists.

Definitions of the Core Level of Service and Level of Quality Criteria for all TTI Core services are given in Table 12 and Table 13. Service specific LoS and LoQ criteria are defined in the respective descriptions.

Table 12: **Level of Quality Criteria table for RTTI and SRTI**

			Applicable for	
	Definition of Quality Criteria for RTTI and SRTI		Event information	Status-oriented Information
Level of Quality	Timeliness (start)	The time between the occurrence of an event and the acceptance of the event.	X	–
	Reporting period	The time interval for refreshing / updating the status reports	–	X
	Timeliness (update)	The time between the end or (safety) relevant change of condition and the acceptance of this change	X	
		The average age of the sensor data used in the most recent reporting period		X
	Latency (content side)	The time between the acceptance of the event or its end or (safety) relevant change of condition and the moment the information is provided by the content access point	X	–
		The time between the calculation of the reporting data and the moment the information is provided by the content access point	–	X
	Location accuracy	The relative accuracy of the referenced location for the published event with respect to the actual location of the actual event	X	–
	Classification correctness	100% minus the percentage of the published events which are known to be not correct, concerning actual occurrence of this event type / class	X	–
	Error rate	Percentage of published status reports which show excessive deviations of a reported quantity (e.g. speed or travel time) versus the actual value or are otherwise determined as erroneous	–	X
	Event coverage	Percentage of the events which are known to be correctly detected and published by type / class, time and location (i.e. detection rate)	X	–
	Report coverage	The percentage of reporting locations for which a status report is received in any given reporting period	–	X

Table 13: **Level of Quality Criteria table for MMTI**

			Applicable for (as minimum criterion)	
	Definition of Criteria for MMTIS		**Event information (actual)**	**Status / Entity information (actual)**
Level of Quality	Timeliness (start)	The time between the occurrence of an event and the acceptance of the event.	X (no)	–
	Reporting period	The time interval for refreshing / updating the status reports - replacing "Timeliness (start)", as with status reporting there is no start.	–	X (no)
	Timeliness (update)	The time between the end or relevant change of condition and the acceptance of this change.	X (no)	
	Reporting period	The average age of data used in the most recent reporting period - redefinition of "Timeliness (update)" for status reporting.		X (no)
	Latency (content side)	The time between the acceptance of the event and the moment the information is provided by the content access point.	X (yes)	
		The time between the calculation of the reporting data and the moment the information is provided by the content access point - redefinition of "Latency (content side)" for status reporting.		X (yes)
	Location accuracy Error rate	The relative precision of the referenced location for the published entity or event with respect to what is considered as the corresponding true position of the actual entity or event. (NB: several possibilities - for a point, stop, access node, road or area)	X (yes)	–
		Percentage of the values for a service which are different from the ground truth.	X (no)	–
	Event coverage	Percentage of the actually occurring events which are known to be correctly detected and published by type, time and location (i.e. Detection Rate).	X (no)	–
	Report coverage	The percentage of reporting locations for which a status report is received in any given reporting period - replacing "event coverage" for status reporting.	–	X (no)
	Completeness of data	Percentage of data entities available in the service provision with respect to the total data entities of that service or data type for which quality criteria have been defined. More precisely, for a given service or data type, are all the data entities foreseen in the Regulation provided?	X (yes)	X (yes)

3.1.5.2 Levels of Service

The descriptions in this manual, including the definitions of the level of service for each of the European ITS Core services, provide the information needed by road operators to ensure that implementations are carried out in support of European cohesion and define steps for the gradual improvement of the service in relation to the European ITS Core service operating environments.

Each of the ITS Core service descriptions for traffic and travel information has been developed using an information content based approach which lends itself to a description of the levels of service which are purely end user oriented in terms of information content.

The levels of service therefore define the quality of the relationship to the user. The differences between the five information services mean that different criteria may be more important for different information services. To this end, each TTI Core service description includes a Level of Service table, which recommends the end user oriented levels of service that should be progressed towards to assist in the realisation of interoperable, seamless and harmonised pan-European Services.

Table 14: **Levels of Service criteria table**

Levels of Service Criteria Table	
Core Criteria	**Definition**
User interface (Previously "Language and Provision")	Relates to the interface between information and the user: Information should be capable of being displayed through pictograms (language independent), or through a common and shared language + native language; or in the native language of the country.
Neighbouring Provision	Addresses the issue of information exchange and availability between Operators managing neighbouring network. Service providers dealing with several different sources
Local and Secondary Network Information	Deals with necessary travel information about non TEN-T routes, provided on TEN-T routes. Level 1 could include for instance the exchange and use of information for the more strategic non TEN-T routes, which are likely to form parts of strategic networks. Level 2 would seek to provide additional information on local routes which impact on the strategic network but are not deemed key routes themselves.
Level of detail (Previously "Location Reference")	Gives understanding on the necessary georeferencing precision required for travel information. Qualifies the geographic "granularity" of the information. None means no specific location i.e. area / road
Static / Dynamic	Notes the relevance of different types of data/ information availability with progress towards the combination of static data with all required dynamic data.

Note: There is no hierarchy between the criteria and no additional weighting given to one with a higher level of service. Not all services will define requirements for all criteria presented in the above table.

3.2 TTIS-01 Forecast and Real-time Event Information

3.2.1 ITS service at a glance

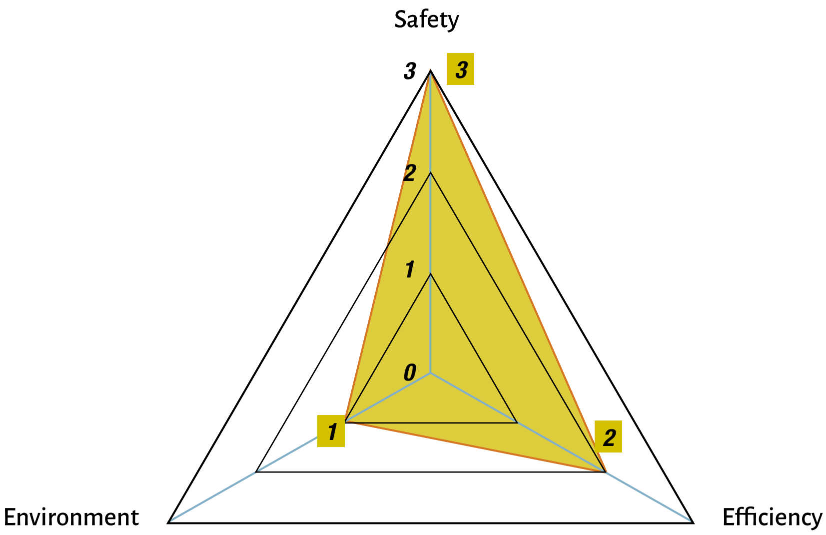
Service definition

"Forecast and Real-time Event Information Services" are defined as the provision of information about both expected and unexpected events to road users on identified segments of the road network and interfaces. This predictive or real-time information could be provided on-trip and pre-trip using different information channels, accessible by the road user via different end-user devices. The service may comprise common information as well as individual (personalised, on-demand) information.
"Events" are defined as - expected or unexpected – abnormal situations, which may lead to adverse effects on the road regarding to traffic safety, efficiency and environmental effects.

Service objective

The main objective of providing forecast and real-time event information and warnings to the road user is improving the safety and the efficiency of the network.
Expected and unexpected events can develop into a traffic bottleneck, due to abrupt reactions of uninformed drivers. However, if those drivers know the upcoming traffic situation in advance they would be prepared and could pro-actively adapt their speed and following distance, thus preserving smooth, stable and safe traffic flow.
Forecast and Real-time Event Information services allow traffic information to be factored into both pre- and on-trip journey planning. This can alter the departure times, assist the driver to take more effective routing decisions, where appropriate, search information for another means of transport or even alter the decision to travel.
The provision of information to drivers enhances the travelling experience even if the information does not directly have an impact on network efficiency or safety. Better-informed drivers tend to be calmer and hence more concentrated. Other impacts can be the increased mode share of public transport, when drivers decided to select another mode of transport for their trip and reduced air pollution.

Service benefit radar



ITS service key words

Real-time Event Information, incident, accident

3.2.2 Harmonization requirements and advice

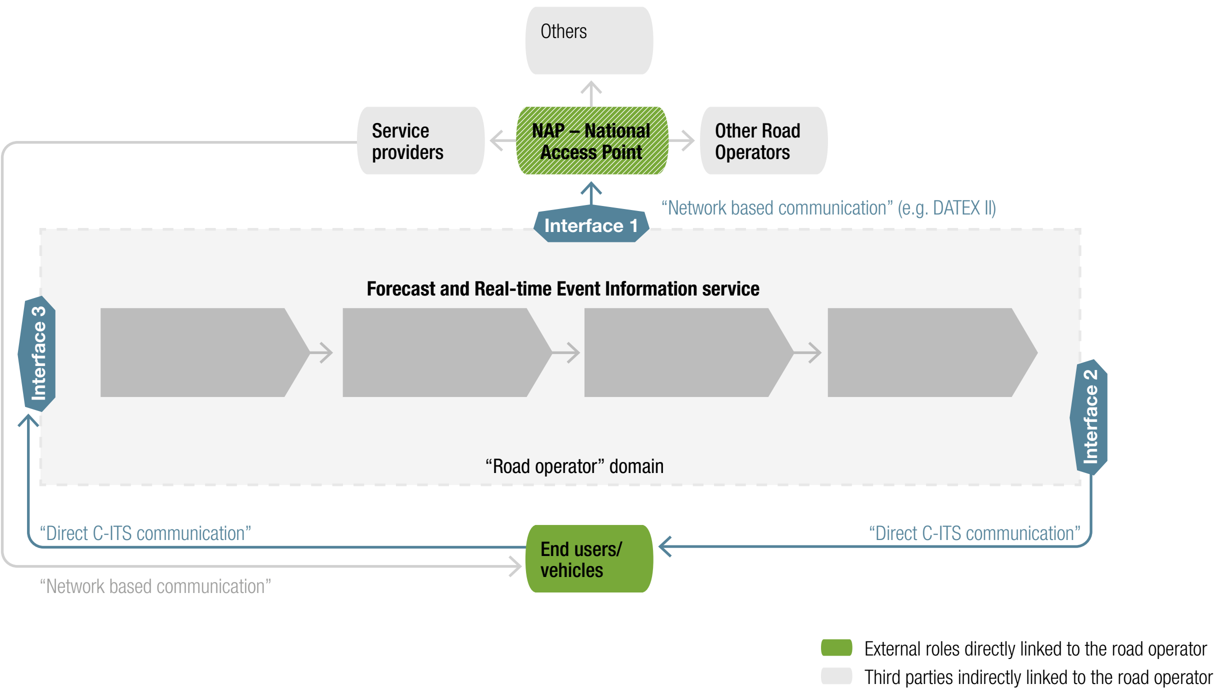
3.2.2.1 Functional requirements and advice

3.2.2.1.1 Functional architecture

The function of the service is to provide forecast and real-time event information to road users either pre-trip or on-trip. This may be demand-responsive or initiated by the information providers. In Europe, both private and public information providers are involved in this information provision (see organisational requirements). More information on the cooperation between public and private partners is provided in chapter 4.1.4.2.

Based on the TISA/CEDR value chain, Figure 21 shows the typical functional architecture of a "Forecast and Real-time Event Information service", consisting of four subfunctions:

Figure 21: **Functional architecture of the Forecast and Real-time Event service**



3.2.2.1.2 Functional requirements and advice

Functional requirement:

— **FR1:** Functional decomposition into sub-functions with the provision of interfaces **must** be carried out to enable interoperability in cases that the service is carried out by more than one organisation

Subfunction 1 "Detection and content collection"

Devices, tools and methodologies for traffic data collection are not covered by this service description. They depend amongst other things on the particular data collection system used and are left to the operator to select.

Note: "Detection and content collection" is not only done by automatic data collection systems. "Events" are also announced/signalled by so-called 'non-technical sources' such as police, fire brigades, local authorities, road users as well as 'generated' by actions of the road operator.

Functional requirement:

- **FR2:** Beneath real-time data also historic data **should** be used to generate event predictions.

Sub-function 2 "Content pre-procession"

Note: Content pre-procession includes data validation and certification.

Within Europe different methodologies exist to aggregate collected data and other input information for forecast and real-time event information. These methodologies are not covered by the present guideline and are left to the operator to select. They depend amongst others on the particular data fusion and processing system used and particular traffic model applied.

Functional requirements:

- **FR3**: Source, scope and quality (based on a quality model to be defined) of data provided by content owners[18] to content providers **must** be defined by the partners and **must** be part of data interface description.
- **FR4**: The quality of the data **should** be in line with the Quality Package defined in EU-EIP Activity 4.1

Sub-function 3 "Info-service provision"

Different service providers in accordance with specific business models carry out information provision. The information provision to the road user on end-user devices has to be done using various information channels. When providing customer-oriented Forecast and Real-time Event Information services, the users' benefit can be increased by providing event information in combination with general traffic information (i.e. see "TTIS-02 - Traffic Condition and Travel Time Information", "TTIS-03 - Speed Limit Information" and "TTIS-04 – Road Weather information").

Sub-function 4 "Info-service presentation"

Functional requirement:

- **FR5**: Beneath the means of information provision (information channels and end user devices), where applicable the area (territory) and locations of information dissemination **should** be defined in relation to the media used.

3.2.2.2 Interface requirements

Interface requirements a): Safety Related Events as listed in Delegated Regulation (EU) 886/2013 (SRTI)

- **IFR1a:** If the Forecast and Real-time Event Information service provides data of one or more of the categories listed below, it **must** provide interface 1 (see Figure 21) coded information following the Delegated Regulation (EU) 886/2013 (SRTI) and as specified in the Document "Safety related message sets – Selection of DATEX II Codes, DENM Event Types, TPEG2-TEC Causes and TMC Events for EC high level Categories".
  - (a) temporary slippery road
  - (b) animal, people, obstacles, debris on the road

18 Definition and description of the key actors: see 3.1.4

  - (c) unprotected accident area
  - (d) short-term road works
  - (e) reduced visibility
  - (f) wrong-way driver
  - (g) unmanaged blockage of a road
  - (h) exceptional weather conditions.
- **IFR2a:** If interface 2 is implemented, the Forecast and Real-time Event Information service **must** provide at interface 2 (see Figure 21) C-ITS coded real-time information on the event categories required in Delegated Regulation 886/2013 (SRTI), including the location of the following elements:
  - temporarily slippery road
  - animal, people, obstacles, debris on the road
  - unprotected accident area
  - road works
  - wrong-way driver
  - unmanaged blockage of a road
  - reduced visibility
  - exceptional weather conditions
- **IFR3a**: When relevant, the Forecast and Real-time Event Information service **should** collect at interface 3 (see Figure 21) C-ITS coded Information from C-ITS equipped end user devices/vehicles relevant to this ITS Core service such as travel speed, direction, current location of a vehicle.

Interface requirements b): Real-time Related Events as listed in Delegated Regulation (EU) 2015/962 (RTTI)

- **IFR1b:** If the Forecast and Real-time Event Information service provides data of one or more of the categories listed below, it **must** provide at interface 1 (see Figure 21) coded information following the Delegated Regulation (EU) 2015/962 (RTTI).
  - (a) road closures
  - (b) lane closures
  - (c) bridge closures
  - (e) roadworks
  - (f) accidents and incidents
  - (i) poor road conditions
  - (p) weather conditions affecting road surface and visibility
- **IFR2b:** If interface 2 is implemented , the Forecast and Real-time Event Information service **should** provide at interface 2 (see Figure 21) C-ITS coded real-time information on the event categories required in Delegated Regulation 2015/962 (RRTI) and listed below, in detail specified ….
  - road closures
  - lane closures
  - roadworks
  - accidents and incidents
  - weather conditions affecting road surface and visibility
- **IFR3b**: When relevant, the Forecast and Real-time Event Information service **should** collect at interface 3 (see Figure 21) C-ITS coded real-time information from C-ITS equipped end user devices/vehicles relevant to this ITS Core service such as travel speed, direction, current location of a vehicle.

3.2.2.3 Organisational requirements and advice

Organisational Architecture/Business Model

A general overarching description of the key actors, their roles in the value chain and the related conditions for TTI service provision are outlined in Chapter 3.1. More information on new models of cooperation between public and private partners can be found in chapter 4.1.4.2

Note: Even though partners involved in the service can be either public or private road organisations as well as public or private service providers, who are legally autonomous in varying degrees and in the international context even work on different national laws, it is not required to define organisational aspects on a legal and binding basis.

Organisational advice:

— Where different autonomous parties are involved, clear definitions of organisational aspects are a crucial precondition for a successful implementation of a "Forecast and real-time event information service". These definitions are documented in the form of e.g. a "Common partner arrangement" or a "MoU - Memorandum of understanding" which establish the roles and responsibilities of the respective parties to any co-operation and be agreed by all parties/ partners involved.

Organisational requirements:

— **OR1**: The organisational and operational structure of the service as well as the role of each public organisation/body and its exact responsibility and task in the chain **must** be compliant with the National Access Points across Europe, within the scope of the implementation of the delegated acts adopted under Directive 2010/40/EU.

— **OR2**: All necessary organisational aspects for successful implementation of a "Forecast and Real-time Event Information Service" **must** be documented and agreed by all involved parties/ partners to secure the cooperation.

— **OR3**: All necessary collaboration processes/workflows and interfaces **must** be described.

— **OR4**: The information provision **should** be in accordance with any management plans (TMP, see TMSDG07) which are in operation of the road authorities or traffic management centres.

3.2.2.4 Common look & feel requirements and advice

Common Look & Feel requirements:

— **CL&FR1**: Information for the end user **should** always be consistent whatever media or end user device is used.

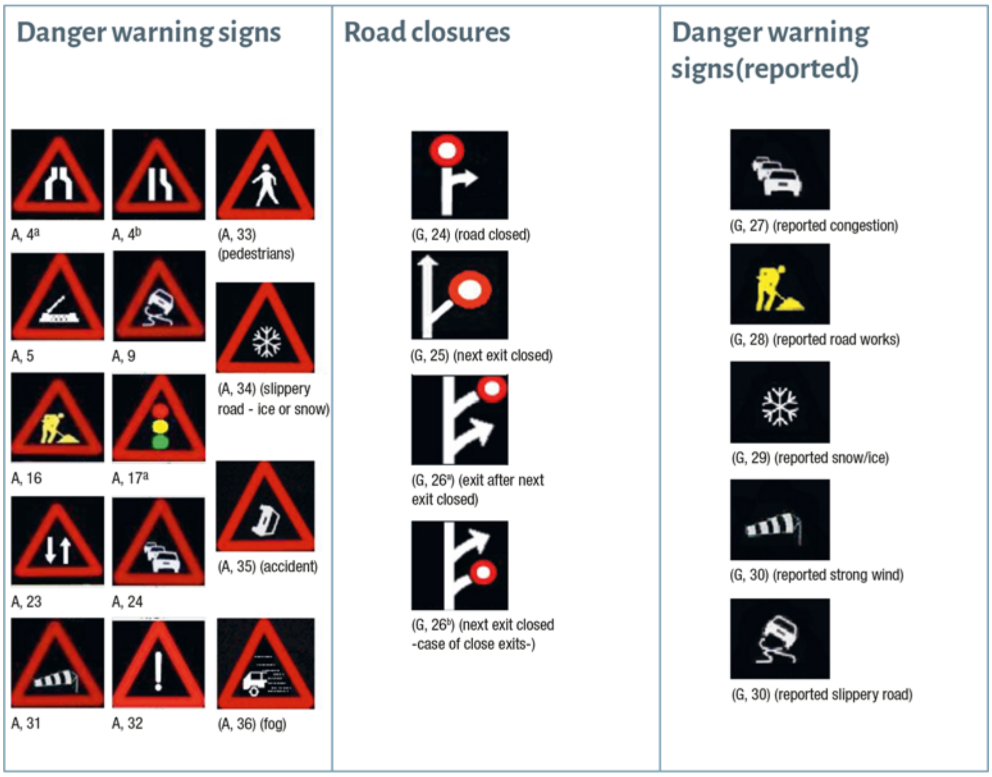
— **CL&FR2**: The display of signs/pictograms on VMS or other end-user devices **should** be in accordance with prevailing national road codes and:

— Member States which ratified the Vienna Convention MUST respect the Vienna Convention and the European agreement supplementing the convention (1st May 1971) and SHOULD consider the Consolidated Resolution on Road Signs and Signals (R.E.2).

— Member States which did not ratify the Vienna Convention SHOULD follow the Vienna Convention and also consider the R.E.2.

It is up to the deploying road operator to ensure that signs are well and widely understood by the road users, even if some local variations to the Vienna Convention should be adopted in some countries.

Figure 22: **Vienna convention - Consolidated Resolution on Road Signs and Signals (R.E.2) - Event information signs**



3.2.2.5 ICT Infrastructure requirements and advice

No specific requirements or advice.

3.2.2.6 Required standards and specifications

Information provision standards a): Safety Related Events as listed in Delegated Regulation (EU) 886/2013 (SRTI)

- **IPS1a**: If a service for Forecast and Real-time Event Information is implemented at interface 1, Safety Related Traffic Information (see IFR1a) **must** be profiled based on EN 16157-3:2019 using the DATEX II Recommended Service Profile for Safety Related Traffic Information.
- **IPS2a**: If interface 2 is implemented, Safety Related Traffic Information (see IFR2a) **should** be provided based on ETSI EN 302 637-2 using the C-ROADS C-ITS Message Profiles for the Hazardous Location Notification and Road Works Warning services and the use cases TSR, APR, OR, AZ, SV, WCW, AWWD, UBR as defined in the “C-ROADS Common C-ITS Service and Use Case Definitions”.
- **IPS3a**: When relevant, the Safety Related Traffic Information (see IFR3a) **should** be collected from C-ITS equipped vehicles based on ETSI EN 302 637-2 using the CAR 2 CAR Communication Consortium Basic System Profile.

Information provision standards b): Real-time Related Events as listed in Delegated Regulation (EU) 2015/962 (RTTI)

- **IPS1b**: **If** a service for Forecast and Real-time Event Information is implemented at interface 1, Real-time Traffic Information (see IFR1b) **must** be profiled based on EN 16153 using the DATEX II Recommended Service Profiles for Real-time Traffic Information or any international machine-readable format fully compatible and interoperable with DATEX II.

— **IPS2b**: If interface 2 is implemented, Real-time Related Traffic Information (see IFR2b) **must** be provided based on ETSI EN 302 637-2 using the C-ROADS C-ITS Message Profiles for the Hazardous Location Notification and Road Works Warning services and the use cases AZ, UBR, WCW as defined in the C-ROADS Common C-ITS Service and Use Case Definitions.
— **IPS3b**: When relevant, the Probe Vehicle Data (microscopic traffic situation) information (see IFR3) such as travel speed, direction, current location of a vehicle **should** be collected, which is profiled based on ETSI EN 302 637-2 using the CAR2CAR Communication Consortium Basic System Profile.

3.2.2.7 Level of Quality and Service definition

3.2.2.7.1 Level of Quality criteria

The "Levels of Quality table" for the definition of quality criteria for RTTI and SRTI services, which differentiates data quality into "basic", "enhanced" and "advanced" (for detailed information see Quality of S Real-Time Services - Quality package) reflects the requirements for the data quality which are needed for Forecast and Real-time Event Information services. This table is not end-user oriented as Table 16.

Level of Quality advice:

— It is recommended that Forecast and Real-time Event services fulfil the "Basic quality level" as a minimum.

3.2.2.7.2 Level of Service criteria

Table 15 gives the Level of Service recommendations for a Forecast and Real-time Event Information service. The background of this concept is descripted in chapter 2.6.

Table 15: **Level of Service recommendations for Forecast and Real-time Event Information**

Levels of Service criteria table: Forecast and Real-time Event Information			
Core Criteria	A	B	C
User interface* **(Language)**	One fixed language (all official languages)	Information available is capable of being provided in addition, in a common and shared language	Information available is capable of being provided independent of language
Neighbouring** **Provision**	No traffic information exchange	Information exchange to neighbouring only	Neighbouring and beyond information provider exchange
Local and*** **secondary Network Information**	None (only information on TEN-T road network)	Exchange and use for strategic non-TEN-T road network (key roads)	Additional information on local routes with impact on the TEN-T road network
Level of Detail (Location Reference)	Road or location name	Route specific segments (between 2 junctions)	Road segment specific (approx. 1 km or precise location)

Legend:
*__User Interface__: This criterion relates to the interface between information and the user. Information should be capable of being displayed through pictograms (language independent) as an optimum, in an official language or an official language plus a shared language (English) as an intermediate level
**__Neighbouring Provision__: Addresses the issue of information exchange and availability between Operators managing neighbouring network. Service providers dealing with several different sources
***__Local and secondary Network Information__ (see LoQ for more details): Deals with provision of information relevant for non-TEN-T routes, provided on TEN-T routes.

3.2.2.7.3 Level of Service Criteria related to Operating Environment

Level of service requirement:

LoSR1: In the case that pre-deployment surveys / evaluations provide the necessary evidence to proceed with the deployment of the ITS-service "Forecast and Real-time Event Information", the minimum and optimum LoS **should** respect the following Level of Service to Operating Environment mapping table.

Table 16: **Level of Service to Operating Environment mapping table (see also chapter 2.5.3 and ANNEX C)**

FORECAST AND REAL TIME EVENTS INFORMATION SERVICE			Operating Environment													
Criteria for the Level of Service			C1	T1	T2	T3	T4	R1	R2	R3	R4	S1	S2	N1	N2	P1
User Interface	C	Information available is capable of being provided independent of language	O	O	O	O	O		O		O	O	O	O	O	O
	B	Data available is capable of being provided in addition in a common and shared language								O						
	A	One fixed language (all official languages)			M	M	M		M	M	M	M		M		M
Neighbouring Provision	C	Neighbouring and beyond Information Provider exchange														
	B	Information exchange to neighbouring only	O			O	O					O		O		
	A	No traffic information exchange										M	M	M		
Local and secondary Network Information	C	Additional information on local routes with impact on the TEN-T road network														
	B	Exchange and use for strategic non TEN-T road network (key roads)	O		O	O	O		O	O	O		O		O	
	A	None (only information on TEN-T road network)	M		M	M	M		M	M	M	M	M	M	M	M
Level of Detail (Location Reference)	C	Road segment specific (approx. 1 km or precise location)										O	O	O	O	
	B	Route specific segments (between 2 junctions)														
	A	Road or location name										M	M	M	M	M

Recommendatons for LoS per OE:

M	Minimum LoS recommended	O	Optimum LoS recommended
OM	Minimum = Optimum	NA	Non relevant

3.3 TTIS-02 Traffic Condition and Travel Time Information

3.3.1 ITS service at a glance

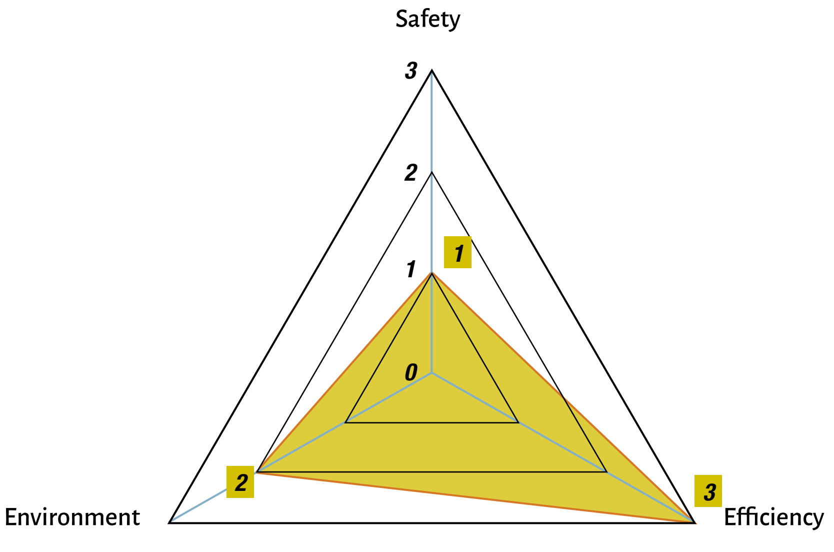
Service definition

"Traffic Condition and Travel Time Information service" means the provision of information on the traffic conditions (LoS) and travel times on identified road segments of the network.
Traffic Condition / Level of service (LoS) is a qualitative measure used to relate the quality of traffic service. LoS is used to analyse road networks by categorising traffic flow and assigning quality levels of traffic based on performance measure shuck as speed, volume, delay etc. This is typically based on the continuity of flow.
Travel time is the total elapsed time necessary for a vehicle to travel from one point to another over a specified route under existing traffic conditions.
As the volume of traffic approaching a point exceeds capacity, LoS falls, and traffic is characterised by stop-and-go waves, poor travel times, low driver comfort, and increased accident exposure.
This predictive or real-time information can be provided both on-trip and pre-trip using different information channels.

Service objective

A road user provided with high quality traffic condition and travel time information will react to the information and adapt their travelling and driving behaviour; this could mean changing routes or trip scheduling; as well as reducing speed in congestion.
Thus, the road network is used in a more efficient and safe way, with significant contributions to improving environmental performance, energy efficiency and security of road transport.

Service benefit radar



ITS service key words

Travel time, Traffic condition, Level of Service (LoS), traffic flow, traffic speed, volume, delay, congestion

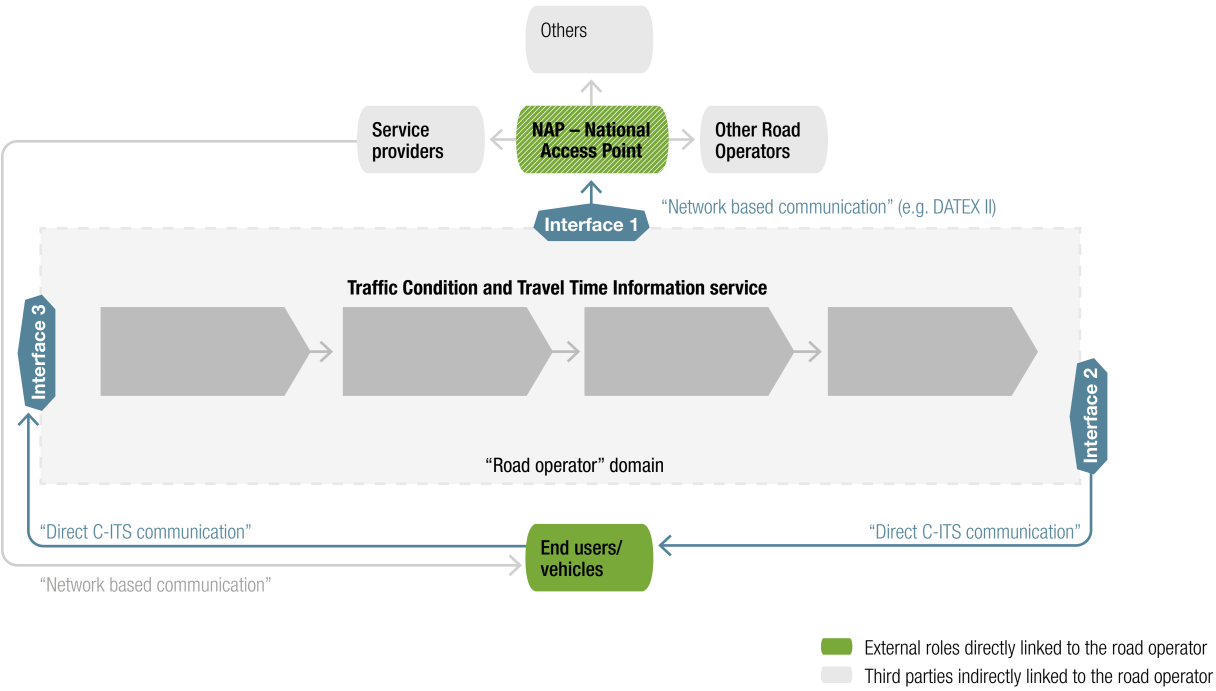
3.3.2 Harmonization requirements and advice

3.3.2.1 Functional requirements and advice

3.3.2.1.1 Functional architecture

The following figure shows the typical functional architecture of a "Traffic Condition and Travel Time Information service".

Figure 23: **Functional architecture of the Traffic Condition and Travel Time service**



3.3.2.1.2 Functional requirements and advice

<u>Functional requirements:</u>

— **FR1**: Functional decomposition into sub-functions with the provision of interfaces **must** be carried out to enable interoperability in those cases that the service is provided by more than one organisation

<u>Functional advice:</u>

— Functional decomposition is recommended in any case to be prepared to involve yet further parties as may be the case in the future.

Sub-function 1 "Data collection"

Tools, devices and methodologies for traffic data collection are not covered by this service description. They depend amongst other things upon the particular used data collection system and are left to the operator to select.

Functional requirements:

- **FR2**: All collected and provided data elements **must** contain:
- where applicable, location code(s)
- a time stamp

The geographical basis of the location code should be left to the road operator to define, anyway the model of information provision to other organisations must respect DATEX II location reference and time stamp model.

- **FR3**: Besides real-time data also historic data **should** be used to generate traffic condition and real-time predictions.

Sub-function 2 "Data fusion and processing"

Note: "Data fusion and processing" includes "data validation and certification". Within Europe different methodologies exist to aggregate the real-time and predictive traffic condition and travel time information. These methodologies are not covered by this service description and are left to the operator to select. They depend amongst others on the particularly used data fusion and processing system and particular traffic model applied.

Functional requirement:

- **FR4**: Source, scope and quality of data provided by content owners to content providers **must** be defined by the partners and must be part of data interface description.
- **FR5**: The quality of the data **should** be defined and the travel time information quality should be in line with the relevant quality model.

Sub-function 3 "Information provision"

Different service providers in accordance with specific business models carry out information provision. The information provision to the road user on end-user devices has to be done using various information channels.

Functional requirements:

- **FR6**: All stakeholders and partners involved in the value chain of a Traffic Condition and Travel Time Information service **should** formally agree and accept under which conditions information can be disseminated to the end user, for example:
  - without any restrictions
  - tied to the conditions of an appropriate partnership agreement
- **FR7**: Underlying the information provision (information channels and end user devices), where applicable, the area (territory) and locations of information dissemination **should** be defined in relation to the media used

3.3.2.2 Interface requirements

Interface requirements:

- **IFR1**: If the Traffic Condition and Travel Time service provides data of one or more of the categories listed below at interface 1 (see Figure 23), it **must** provide coded information including the following elements:
  - Location for the traffic conditions and/or travel times
  - Traffic status (Level of Service), and if applicable relevant types of vehicles
  - Current travel times, if applicable also for free flow, and if applicable relevant types of vehicles
  - Relevant Point of time

— **IFR2:** If interface 2 is implemented, the Traffic Condition and Travel Time Information Service **must** provide at interface 2 (see Figure 23) C-ITS coded information on the Traffic Condition and Travel Time including the following elements:
 - the setting of a road sign (what is shown in the sign)
 - the location/relevant area of the sign

— **IFR3**: When relevant, the Traffic Condition and Travel Time Information Service **should** collect at interface 3 (see Figure 23) C-ITS coded information on Probe Vehicle Data (microscopic traffic situation) relevant to this ITS Core service, such as travel speed, direction, current location of a vehicle.

Note: The required/provided information content depends on availability and the levels of quality criteria table agreed among the partners involved

Interface advice:

— In order to provide efficient and adapted information when needed and also to prevent from disseminating counterproductive information additional event-based information and official traffic management plans should be provided, which are covered by other ITS Core services (see TTIS-01 Forecast and Real Time Event Information and TMS-07 Traffic Management for Corridors and Networks)

3.3.2.3 Organisational requirements and advice

Organisational Architecture/Business Model

A general overarching description of the key actors, their roles in the value chain and the related conditions for TTI service provision are outlined in Chapter 3.1. More information on new models of cooperation between public and private partners can be found in chapter 4.1.4.2

Organisational advice:

— Where different autonomous parties are involved, clear definitions of organisational aspects are a crucial precondition for a successful implementation. These definitions should be documented in the form of . "Common partner arrangement" or a "Memorandum of understanding" (MoU), which establishes the roles and responsibilities of the respective parties in any cooperation and is then agreed upon by all parties/partners involved.

Organisational requirements:

— **OR1**: The organisational and operational structure of the service, as well as the role of each organisation/body and its exact roles and tasks in the value chain **must** be compliant with the National Access Points across Europe, within the scope of the implementation of the delegated acts adopted under Directive 2010/40/EU

— **OR2**: All necessary organisational aspects **must** be documented and agreed by all involved parties/partners to ensure cooperation.

— **OR3**: All necessary collaboration processes/workflows and interfaces **must** be described and documented

3.3.2.4 Common Look & Feel requirements and advice

Common Look & Feel advice:

— The core message of information provided for the end user should always be consistent, whatever media or end user device is used for distribution.

Specifically, for traffic condition information

Common Look & Feel requirement:

— **CL&FR1**: The display of signs/pictograms on VMS or other end-user devices **should** be in accordance with prevailing national road codes and:
    - Member States which ratified the Vienna Convention MUST respect the Vienna Convention and the European agreement supplementing the convention (1st May 1971) and SHOULD consider the Consolidated Resolution on Road Signs and Signals (R.E.2).
    - Member States which did not ratify the Vienna Convention SHOULD follow the Vienna Convention and also consider the R.E.2.

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

Specifically, for travel time information

Common Look & Feel requirements:

— **CL&FR3**: The display of travel times and delay times on VMS or other end-user devices (websites, navigation systems…) **should** respect the following format: <XX> min.

— **CL&FR4**: Concerning VMS, the travel time may be complementary with "(+ YY)" to denote the delay in addition to normal travel time. The YY **should** represent the additional time due to perturbation, included in the <XX> part.

— **CL&FR5**: It **should** always be indicated for which location (intersection, exit, city …) the travel time displayed is valid.

Common Look & Feel advice:

Every VMS or other end-user devices providing information about abnormal travel time should also inform as well on the traffic situation.

3.3.2.5 ICT Infrastructure requirements and advice

No specific requirements or advice.

3.3.2.6 Required standards and specifications

Information provision standards:

— **IPS1**: If the Traffic Condition and Travel Time service provides Traffic Condition and Travel Time information (see IFR1), it **must** be profiled based on CEN/TS 16157-5:2020 using the DATEX II Recommended Service Profile for Traffic Condition and Travel Time. The use of the PredefinedLocationsPublication is recommended. For calculated travel time information, the ElaboratedDataPublication is recommended to be used, otherwise the MeasurementSiteTablePublication.

— **IPS2**: If interface 2 is implemented, Traffic Condition and Travel Time information (see IFR2) **must** be profiled in an IVIM (Infrastructure to Vehicle Information Message) based on ISO 19321 using the C-ROADS C-ITS Message Profiles for the IVS-TS use case**.**

— **IPS3**: When relevant, the Probe Vehicle Data (microscopic traffic situation) information (see IFR3) **should** be collected, which is profiled based on ETSI EN 302 637-2 using the CAR2CAR Communication Consortium Basic System Profile.

3.3.2.7 Level of Quality and Service definition

3.3.2.7.1 Level of Quality criteria

The "Levels of Quality table" for the definition of quality criteria for RTTI and SRTI services, which differentiates data quality into "basic", "enhanced" and "advanced" (for detailed information see Quality of S Real-Time Services - Quality package) reflects the requirements for the data quality which are needed for Traffic Condition and Travel Time Information services. This table is not end-user oriented as Table 17.

Level of Quality advice:

— It is recommended that Traffic Condition and Travel Time Information services fulfil the "Basic quality level" as a minimum.

3.3.2.7.2 Level of Service criteria

Table 17 gives the Level of Service recommendations for a Traffic Condition and Travel Time Information service. The background of this concept is descripted in chapter 2.6.

Table 17: **Level of Service recommendations for Traffic Condition and Travel Time Information**

Levels of Service criteria table: Traffic Condition and Travel Time Information			
Core Criteria	**A**	**B**	**C**
User interface*	One fixed language (all official languages)	Information available is capable of being provided in addition in a common and shared language.	Information available is capable of being provided independent of language
Neighbouring Provision**	No information exchange	Information exchange to neighbouring only	Neighbouring and beyond information provider exchange
Local and secondary Network Information***	None (information only on TEN-T road network)	Exchange and use of information for strategic non TEN-T road network (key roads)	If necessary, additional information on local routes with impact on the TEN-T road network
Level of Detail (Location Reference)	None	Route specific segments (e.g. between 2 junctions)	Road segment specific (approx. 1 km)
Static / Dynamic	Static/historical only	Static/historical and partly dynamic	Static/historical and fully dynamic

Legend:
***User Interface:** This criterion relates to the interface between information and the user. Information should be capable of being displayed through pictograms (language independent) as an optimum, in an official language or an official language plus a shared language (English) as an intermediate level
****Neighbouring Provision:** Addresses the issue of information exchange and availability between Operators managing neighbouring network. Service providers dealing with several different sources
*****Local and secondary Network Information** (see LoQ for more details): Deals with provision of information relevant for non-TEN-T routes, provided on TEN-T routes.

3.3.2.7.3 Level of Service criteria related to Operating Environment

Level of service requirement:

— **LoSR1**: In the case that pre-deployment surveys / evaluations provide the necessary evidence to proceed with the deployment of the ITS-service "Traffic Condition and Travel Time Information", the minimum and optimum LoS **should** respect the following Level of Service to Operating Environment mapping table.

Note: Level of services concerning the core criteria "User interface" has only to be considered for traffic condition information (not relevant for travel times).

Table 18: **Level of Service to Operating Environment mapping table (see also chapter 2.5.3 and ANNEX C)**

TRAFFIC CONDITION AND TRAVEL TIME INFORMATION SERVICES			Operating Environment													
Criteria for the Level of Service			C1	T1	T2	T3	T4	R1	R2	R3	R4	S1	S2	N1	N2	P1
User Interface	C	Information available is capable of being provided independent of language	O													
	B	Information available is capable of being provided in a common and shared language.				O	O					O	O			
	A	One fixed language (all official languages)	M	OM	OM	M	M	NA	OM	OM	OM	M	M	OM	OM	OM
Neighbour-ing Provision	C	Neighbouring and beyond information provider exchange	O													
	B	Information exchange to neighbouring only				O	O					O	O			O
	A	No information exchange	M	OM	OM	M	M	NA	OM	OM	OM	OM	M	OM	OM	M
Local and secondary Network Information	C	Additional information on local routes with impact on the TEN-T (road network)	O													
	B	Exchange and use of information for more strategic non TEN-T (road network)				O	O					O	O			O
	A	Only traffic condition and travel time information on TEN-T (road network)	M	OM	OM	M	M	NA	OM	OM	OM	M	M	OM	OM	M
Level of Detail (Location Reference)	C	Road segment specific (approx. 1 km)	O			O	O					O	O	O	O	O
	B	Route specific segments (between 2 junctions)		O	O				O	O	O					
	A	None	M	M	M	M	M	NA	M	M	M	M	M	M	M	M
Static/ Dynamic	C	Static/historical and fully dynamic and fully	O			O	O					O	O	O	O	O
	B	Static/historical and partly dynamic and fully		O	O				O	O	O					
	A	Static/historical only	M	M	M	M	M	NA	M	M	M	M	M	M	M	M

Recommendatons for LoS per OE: M Minimum LoS recommended; O Optimum LoS recommended; OM Minimum = Optimum; NA Non relevant

3.4 TTIS-03 Speed Limit Information

3.4.1 ITS service at a glance

Service definition

Drivers should always drive at an appropriate and safe speed. Speed Limit Information services are implemented to help ensure that the driver always and everywhere knows what the speed limit in force is. Speed limits can be static or dynamic; both can be included in information services, and can be provided to drivers via road signage, road markings and in-vehicle systems.

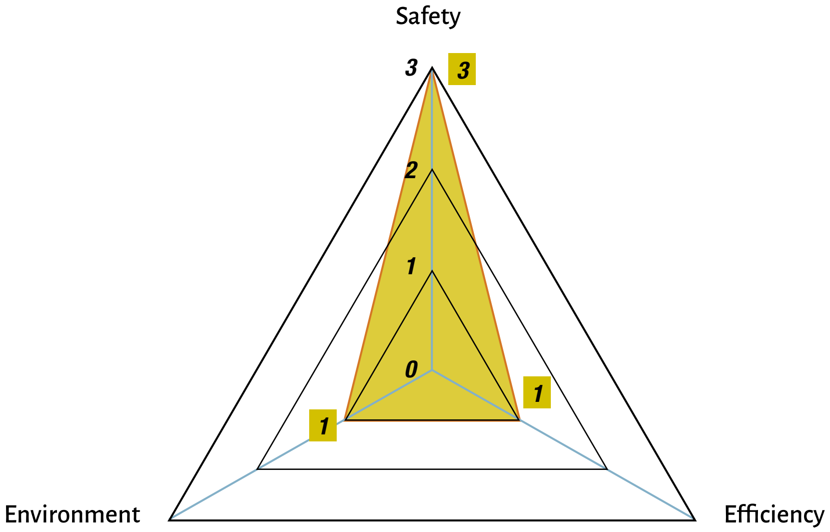
Service objective

For the road user effective speed limit information services mean:
— they always and everywhere know what the speed limit in force is.

For the road operator effective speed limit information services mean:
— collecting and maintaining, accurate and up-to-date speed limit data sets
— ensuring data sets are accessible and useable for traffic management services and service providers in accordance with relevant legislation

By achieving this vision Speed Limit information services can contribute to improved road safety and a reduction in accidents.

Service benefit radar



ITS service key words

Speed limit, static, dynamic

3.4.2 Harmonization requirements and advice

3.4.2.1 Functional requirements and advice

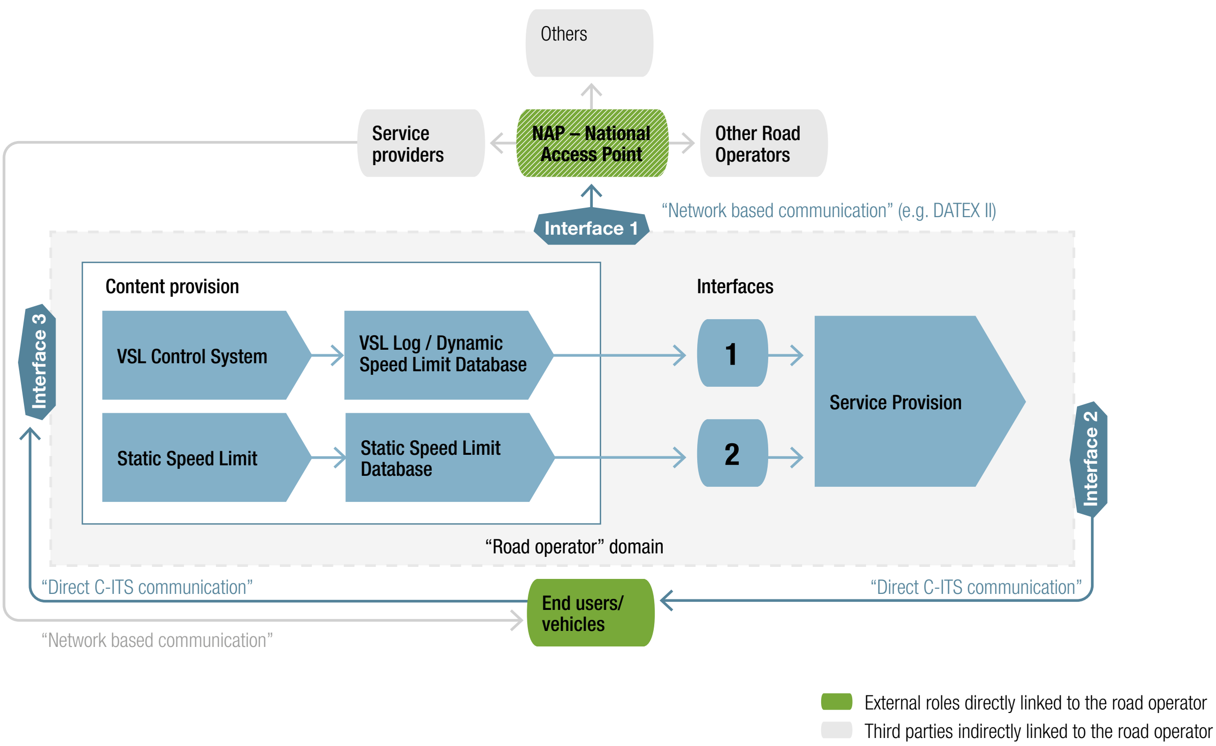
3.4.2.1.1 Functional architecture

The function of the service is to provide speed limit information to road users either pre-trip, for more accurate trip planning, or on-trip. This may be demand responsive or led by the information providers. In Europe, both public and private information providers are involved in this information provision (see organisational requirements). Hence the decomposition of the whole service into sub-functions is necessary identifying interfaces to be standardised.

Figure 24 shows the typical functional architecture of a "Speed Limit Information service" and gives a schematic overview of the typical system architecture required for a speed limit information service, covering

— static speed limit information collection, storage and updating
— dynamic (variable) speed limit (VSL) data processes

Figure 24: **Functional architecture Speed Limit Information value chain**



3.4.2.1.2 Functional requirements and advice

— Functional requirements
— **FR1:** Source, scope and quality of speed limit information provided by content owners to content providers **must** both be defined and part of data interface descriptions.
— **FR2:** Speed Limit Informationcollected and information provided by content owners to content providers **must** be based upon both a consistent geographic reference model and a time validity

model, which both **must** be agreed among parties participating in the service and part of data interface descriptions.

- **FR3:** If a speed limit information service involves road operators and service providers, information exchange platform systems between road operators and service providers **should** be implemented to update the databases
- **FR4:** The frequency of the updates of the speed limit databases **should** be agreed (and published) and ensured by parties participating in the service.
- **FR5:** A feedback loop between service providers and the road operators **should** be put in place to ensure correct data provision and integration in the speed limits databases.

3.4.2.2 Interface requirements

Interface requirements:

- **IFR1**: If the Speed Limit service implemented provides data listed below at interface 1 (see Figure 24), it **must** provide coded information on the current speed limit including the following elements:
  - The maximum Speed Limit
  - Location (section) of the Speed Limit
  - Where necessary, the type of vehicle concerned by the Speed Limit
- **IFR2:** If interface 2 is implemented, the Speed Limit Information Service **must** provide at interface 2 (see Figure 24) C-ITS coded information on the current speed limit including the following elements:
  - the setting of a (variable) Speed Limit sign (gantry)
  - the location of the sign (gantry) and the stretch of road to the next sign (gantry)
  - where necessary, the type of vehicle concerned by the Speed Limit (text)
- **IFR3**: When relevant, the Speed Limit Information service **should** collect at interface 3 (see Figure 24) C¬ITS coded information on Probe Vehicle Data (microscopic traffic situation) such as travel speed, direction, current location of a vehicle relevant to this ITS Core service.

3.4.2.3 Organisational Requirements

Static and dynamic speed limits are data types listed in the Annex of the Commission Delegated Regulation (EU) 2015/962 for the provision of EU-wide real-time traffic information services. This instrument seeks to provide appropriate framework conditions enabling the co-operation of road authorities, road operators and any other ITS service providers involved in the traffic information value chain, and to support the interoperability, compatibility, and continuity of real-time traffic information services across Europe. Therefore, road authorities and road operators collecting speed limit data are obliged to provide it in a standardised format, if available, or in any other machine-readable format to a national access point.

Organisational requirements:

- **OR1:** The organisational and operational structure of the service as well as the role of each public organisation/body and its exact responsibility and task in the chain **must** be compliant with the National Access Points across Europe, within the scope of the implementation of the delegated acts adopted under Directive 2010/40/EU.
- **OR2:** All necessary organisational aspects for successful implementation of a "Speed Limit Information Service" **must** be documented and agreed by all involved parties/partners to establish the cooperation.
- **OR3:** All necessary collaboration processes/workflows and interfaces **must** be described.

Organisational Architecture/Business Model

A general overarching description of the key actors, their roles in the value chain and the related conditions for TTI service provision are outlined in Chapter 3.1. More information on new models of cooperation between public and private partners can be found in chapter 4.1.4.2

Organisational advice:

— It is advised that the public authority, responsible for speed limit regulations, is involved in organisation of the speed limit information service.

Obligation for TTIS provision, data used in the TTIS

Organisational advice:

— As basic safety road data regulated by public authorities, a speed limit information service may be considered as a free of charge service to the user.
— Concerning dynamic speed limit information - some characteristics related to the speed limit in place as road works or speed control measures for example - can be managed by private companies. This data issued by different sources may be under public and private scope, cooperation between all parties is advised.

Enforcement

Numerous concerns regarding the implementation of speed limit information service involve the issue of enforcement. At this stage legal effects (enforcement) only result from traffic signs and not from their representation on board with information systems (e.g. navigation devices).

Monitoring and enforceable obligations arise only in connection with the first one (traffic signs). Static signs and variable message signs count to the legal arrangement of speed limits. In addition, the information about the arranged Speed limits may be given via information systems provided in the vehicle, however this information does not supersede or change the traffic law arrangement; the in-vehicle presentation does not relieve the driver of the responsibility to obey the current traffic law arrangement from VMS and static signs.

Organisational advice:

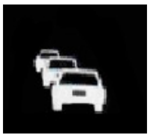
— It must be decided whether the further specification shall be limited to on-board information systems. At least, an accurate differentiation between the legal effects of traffic signs and pure information by onboard systems must be made. It is recommended to exclude Speed Limit Information of enforcement reliability without complete quality check of the information provided.

3.4.2.4 Common Look & Feel requirements

Dynamic speed limit signs are language independent represented in a similar format to traditional metal road signs but using light on a dark background. Dynamic speed limit information may be completed by a danger warning sign or information sign representing the reason for the dynamic speed limit i.e. road works, heavy traffic, raining, slippery road, fog or pollution. Complementary signage should be language independent to ensure all drivers understand important safety information.

ECE/TRANS/WP.1/119/Rev.2 VMS signs concerning speed limit information, and complementary signs, are shown in Figure 25.

Figure 25: **Signs required for Speed Limit Information (taken from ECE/TRANS/WP.1/119/Rev.2)**

VMS Speed Limit Information Signs		VMS Complementary signage (examples)	
			
C,14 Speed limit	C, 17b End of speed limit	A,16 Road works	A, 24 Heavy traffic
			
		G, 27 Congestion	A, 36 fog

Common Look & Feel requirements:

- **CL&FR1:** Speed limits **must** be consistent and there **must** be no discrepancies between the static and dynamic signage of speed limits. If this cannot be achieved, the speed limit will not be displayed.
- **CL&FR2:** Specific complementary signing of speed limit signage **should** be language independent.

3.4.2.5 Required standards and specifications

Information provision standards:

- **IPS1**: If a Speed Limit service is implemented at interface 1, the Speed Limit information (see IFR1) **must** be profiled based on EN 16157-3:2019 using the DATEX II Recommended Service Profile for Speed Limits.
- **IPS2**: If interface 2 is implemented, Speed Limit information (see IFR2) **must** be profiled in an IVIM (Infrastructure to Vehicle Information Message) based on ISO 19321 using the C-ROADS C-ITS Message Profiles for the In-Vehicle Signage service, specifically the Traffic Sign use case as defined in the C-ROADS Common C-ITS Service and Use Case Definitions.
- **IPS3**: When relevant, the Probe Vehicle Data (microscopic traffic situation) information (see IFR3) **should** be collected, which is profiled based on ETSI EN 302 637-2 using the CAR2CAR Communication Consortium Basic System Profile.

3.4.2.6 Level of Service Definition

3.4.2.6.1 Level of Service Criteria

Table 19 gives the Level of Service recommendations for a Speed Limit Information service. The background of this concept is descripted in chapter 2.6.

Table 19: **Level of Service recommendations for Speed Limit Information**

Levels of Service criteria table: Speed Limit information				
Core Criteria		**A**	**B**	**C**
User interface*		One fixed language (official language)	Information available in a common and shared language	Information provided independent of language (speed limit sign)
Neighbouring Provision**		No information exchange	Information exchange to neighbouring network only	Neighbouring network and beyond information provider exchange
Local and secondary* Network Information**		Non applicable. There is no need to be informed about local and secondary network speed limit in place		
Level of Detail* (Location Reference)	**Display on infrastructure (1) recurrence**	To geographic area	Route specific segments (between 2 junctions)	Road segment specific (approx. 10 km)
	Navigation systems (2) completeness	Not complete lots of gaps	Some gaps	No gaps
Static / Dynamic		Static only	Static and partly dynamic/temporary	Static/historical and dynamic

Note: For some service level definition, differences appear concerning dynamic speed limit displaying systems integrated to road side equipment or speed limit databases information provided by in-vehicle systems, that's why both items are treated in two separated cells.

Legend:
***User Interface:** This criterion relates to the interface between information and the user. Information should be capable of being displayed through pictograms (language independent) as an optimum, in an official language or an official language plus a shared language (English) as an intermediate level
****Neighbouring Provision:** Addresses the issue of information exchange and availability between Operators managing neighbouring network. Service providers dealing with several different sources
*****Local and secondary Network Information** (see LoQ for more details): Deals with provision of information relevant for non-TEN-T routes, provided on TEN-T routes..

3.4.2.6.2 Level of Service Criteria related to Operating Environment

Level of service requirement:

— **LoSR1:** In case that pre-deployment surveys/evaluations provide the necessary evidence to proceed with the deployment of the "Speed limit Information service", the minimum and optimum LoS **should** respect the following Level of Service to Operating Environment mapping table.

Table 20: **Level of Service to Operating Environment mapping table (see also chapter 2.5.3 and ANNEX C)**

SPEED LIMIT INFORMATION SERVICE			Operating Environment													
Criteria for the Level of Service			C1	T1	T2	T3	T4	R1	R2	R3	R4	S1	S2	N1	N2	P1
User Interface	C	Data provided independent of language (speed limit sign)	O													
	B	Data available in different or common shared languages				O	O					O	O			
	A	One fixed language	M	OM	OM	M	M	NA	OM	OM	OM	M	M	OM	OM	OM
Neighbouring Provision	C	Exchange with Neighbouring and beyond Information Provider	O													
	B	Beyond information provider exchange				O	O					O	O			O
	A	No exchange	M	OM	OM	M	M	NA	OM	OM	OM	OM	M	OM	OM	M
Level of detail: Display on infrastructure (1) recurrence	C	Road segment specific (approx. 10 km)	O													
	B	Route specific segments (between 2 junctions)				O	O					O	O			O
	A	To geographic area	M	OM	OM	M	M	NA	OM	OM	OM	M	M	OM	OM	M
Level of detail: Navigation systems (2) completeness	C	Complete no gap	O			O	O					O	O	O	O	O
	B	Mostly complete Some gaps		O	O				O	O	O					
	A	Not complete lots of gaps	M	M	M	M	M	NA	M	M	M	M	M	M	M	M
Static/ Dynamic	C	Static and full dynamic	O			O	O					O	O	O	O	O
	B	static and part dynamic/temporary		O	O				O	O	O					
	A	Static only	M	M	M	M	M	NA	M	M	M	M	M	M	M	M

Recommendatons for LoS per OE:

M	Minimum LoS recommended	O	Optimum LoS recommended
OM	Minimum = Optimum	NA	Non relevant

3.5 TTIS-04 Road Weather Information

3.5.1 ITS service at a glance

Service definition

The provision of Road Weather Information Services cover in most cases the following dynamic information:

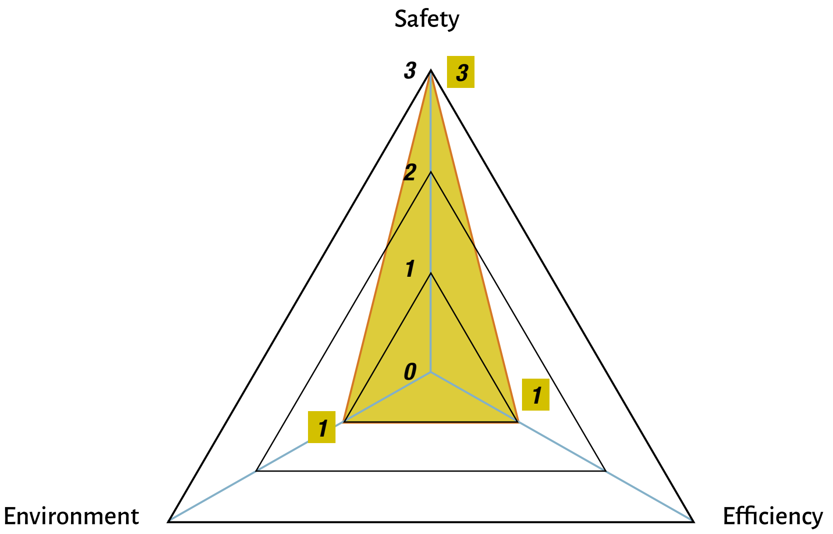
- common weather information/data such as temperature or wind direction/wind speed for regional areas, road traffic related weather messages
- the special forecast Information leading to weather warnings about fog, ice and heavy rain, temporary slippery road, reduced visibility and exceptional weather conditions
- the infrastructure specific information on weather sensitive parts of the network such as a bridge (which can be closed due to special wind conditions). This information assumes particular significance (i.e. negative influence on road safety) particularly in areas which experience extreme climatic conditions, for example, the Baltic area or the alpine countries

These pre-trip and on-trip weather information are important for the end users in order to optimize and better anticipate their journey ahead.

Service objective

The main objective of providing weather information to the driver is improving the traffic safety and the efficiency of the European road transportation system.
If drivers are informed of the upcoming weather situation they are able to adapt their driving behaviour. Road weather information can be factored into both pre- and on-trip journey planning. This may avoid congestion and decrease the number of fatalities and accidents.

Service benefit radar



ITS service key words

Road Weather information, weather warnings, weather notifications, day 1 C-ITS services

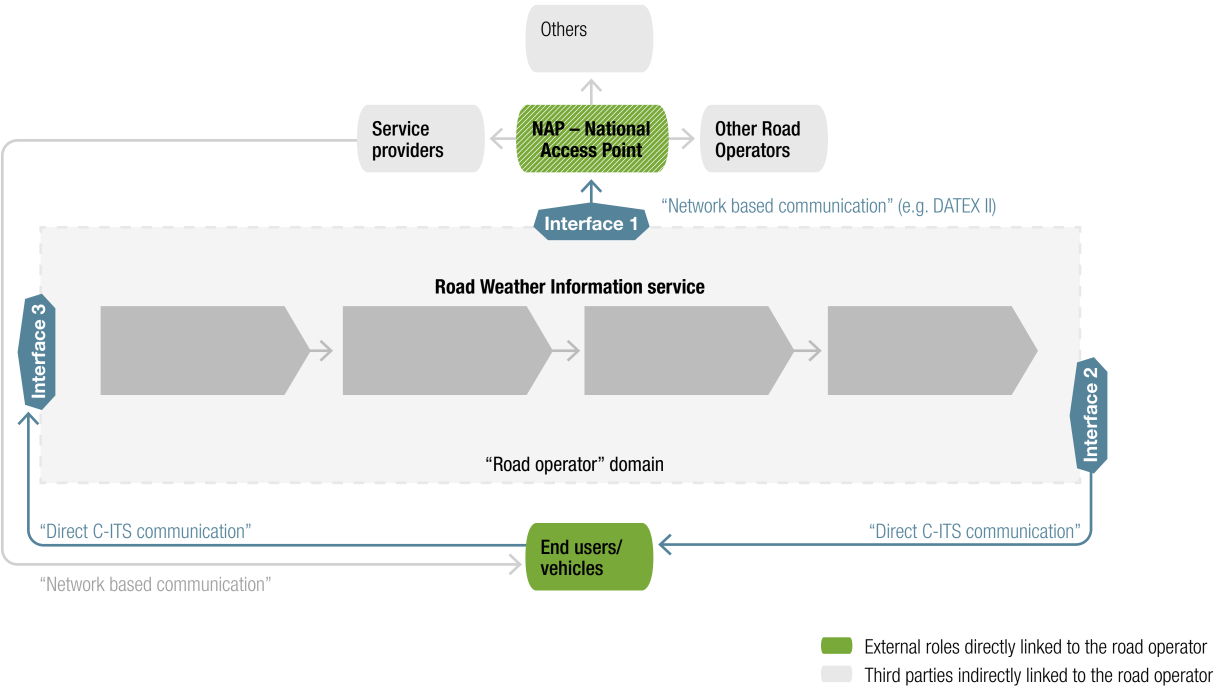
3.5.2 Harmonization requirements and advice

3.5.2.1 Functional requirements and advice

3.5.2.1.1 Functional architecture

Figure 26 shows the typical functional and informational architecture of the "Road Weather Information Services" and gives a schematic overview of the typical system architecture required for both weather information and weather warnings.

Figure 26: **Functional Architecture of the Road Weather Information service**



3.5.2.1.2 Functional requirements and advice

Functional requirements:

— **FR1:** The Road Weather Information service **should** support road maintenance and infrastructure management (expert service) and **should** be able to collect process and disseminate weather information for travellers (end user service).

— **FR2:** The Road Weather Information **should** provide information in the native language(s) at the output location, and from a user selected choice of other appropriate foreign languages, when applicable.

— **FR3:** The Graphical User Interface (GUI) **should** provide information using graphical representation or text. Graphical form **should** include the use of maps as well as text.

Functional advice:

Note: Beside the provision of road weather information other services could benefit from weather information. This provision is not directly the scope of a Road weather information service and therefore the following list is to be seen as functional advice (not a requirement). However, a clear definition of interfaces is needed at a later stage in the development of any further specification:

— The provision of the Road Weather Information service may also assist other services in the planning of (Multimodal) routes/ finding of alternative routes and assist in any decision by the user to switch mode (weather information as e.g. input parameter for multimodal services)
— The Road Weather Information service may be able to recommend short term road maintenance activities, including winter maintenance, based on data collected from the road infrastructure possibly combined with the current and/or forecast weather conditions[19].
— The Road Weather Information service may support time predictions for a particular trip (road weather information as inputs parameter for a travel time estimation given to users by info services).
— The Road Weather Information service should have a minimum impact on the driving task (distraction).
— The Road Weather Information service must not do anything to reduce the safety of either the travellers in the vehicle (e.g. distracting drivers by overloading them with too much simultaneous information), or the staff using to operational equipment, e.g. in toll booths.
— The Road Weather information services may be delivered in the following ways in any combination:
  - as an information service for non-recurring requests
  - as a subscription service for periodical requests with the same request parameters for a specific route or area and a defined time period
  - as a monitoring service to monitor a specific area or a requested route during a trip. In case of a monitoring service only relevant weather warnings (alerts) shall be provided to the user.

3.5.2.2 Interface requirements

Interface requirement a): Safety Related Events as listed in Delegated Regulation (EU) 886/2013 (SRTI)

— **IFR1a:** If a service for Road Weather Information is implemented at interface 1 (Figure 27) and it provides data on one or more of the categories listed below,
  - (a) temporary slippery road
  - (e) reduced visibility
  - (h) exceptional weather conditions

  the service **must** provide coded information following the Delegated Regulation (EU) 886/2013 (SRTI) and as specified in the Document "Safety related message sets – Selection of DATEX II Codes, DENM Event Types, TPEG2-TEC Causes and TMC Events for EC high level Categories" including the following elements:
  - location of the event or the condition
  - the category of event or condition (short description of it)
  - driving behaviour advice, where appropriate

Interface requirements b): Real Time Related Events as listed in Delegated Regulation (EU) 2015/962 (RTTI)

IFR1b: If a service for Road Weather Information is implemented at interface 1 (see Figure 27) and it provides data on (p) weather conditions affecting road surface and visibility, the service **must** provide coded information following the Delegated Regulation (EU) 2015/962 (RTTI) including the following elements:
  - location of the event or the condition

19 So there is no ambiguity in the decision making process a balance needs to be struck between what the system can recommend in terms of short term road maintenance activities and the contractual responsibilities of the Maintenance Providers.

- the category of event or condition (short description of it)
- driving behaviour advice, where appropriate

— **IFR2**: If interface 2 is implemented, the Road Weather Information Service **must** provide at interface 2 (see Figure 27) Weather information coded in C-ITS messages including the following elements:
- Location of the weather warning area
- Location of slippery roads
- Relevant road signs regarding the weather situation

— **IFR3:** When relevant, the Weather Information Service **should** collect at interface 3 (see Figure 26) C-ITS coded Probe Vehicle Data information (microscopic traffic situation such as travel speed, travel direction, steering position, current location of a vehicle, traction information) relevant to this ITS Core service.

3.5.2.3 Organisational Requirements

Organisational Architecture/Business Model

A general overarching description of the key actors, their roles in the value chain and the related conditions for TTI service provision are outlined in Chapter 3.1.4. More information on new models of cooperation between public and private partners can be found in chapter 4.1.4.2

Organisational advice:

— The recommended organizational characteristics for minimum LoS[20] in the area of safety critical Operating Environments (C1, T2, T4, R2, R4, R6, R8), are as follows:
- Organisation of the TIS: **A.1, A.2, A.3** or **A.4**
- Obligations for TIS provision: **B.1**
- Data used in the TIS: **C.1** or **C.2**
- Business model of the TIS: **D.1**

Organisational requirements:

— **OR1**: Public administrations **must** act according to the assigned scope of their activities, which is normally regulated by law or similar regulations. In the field of the road weather information service provision, it has therefore to be distinguished between mandatory services and non-mandatory (voluntary) ones according to national laws.

— **OR2**: If a guarantee is needed that a service is provided in a single country, a regulation **must** be issued.

3.5.2.4 Common Look & Feel requirements

Common Look & Feel requirements:

— **CL&FR1:** Three or four levels **should** be indicated based on seriousness/ probability of the event when providing a web-based information service. It is recommended that the levels are defined based on local circumstances. However, the message for the drivers should be clearly communicated and be the same across Europe
- Level 0 (normal conditions) - message for drivers: be prepared
- Level 1 (moderate conditions) - message for drivers: drive carefully[21]

20 In 3.5.2.8 the optimum and minimum Level of Service for EU EIP operating environments are defined
21 Level 1 could be merged with Level 2 to communicate only three levels towards the end users

- Level 2 (strong conditions)- message for drivers: special attention needed[22]
- Level 3 (extreme conditions) - message for drivers: take action (in accordance with regulations from each Member State, regarding the type of extreme condition of weather and what means "extreme weather" in that country)

— **CL&FR2:** A graphical representation **should** use a pictogram + a coloured bar to indicate the level of seriousness/ probability when providing a web-based information service.
- Level 0 (normal conditions) - green
- Level 1 (moderate conditions) - yellow[23]
- Level 2 (strong conditions)- orange[24]
- Level 3 (extreme conditions) - red

— **CL&FR3:** As content for pictograms the defined set of content for pictograms **should** be used when providing a web-based information service will be aligned with the pictograms regarding weather information from Vienna Convention. It is recommended that the limits are defined based on local circumstances.
- rain: 3 rain drops
- thunderstorm, lightning
- snow / ice: snow flake
- fog: fog
- slippery road surface: slippery road (according Vienna convention)
- wind: wind cone
- flood: house on the waves
- avalanche: lumps falling from the mountain
- forest fires: fir in flames
- coastal events: two waves

To support the above-mentioned CL&FR3, the EGs take into consideration that the same symbols will be used as in the European weather warning system Meteoalarm, provided by Eumetnet, which is a network of public European weather services. With these symbols and warning levels mentioned above the warnings would already be coherent among most of the European weather services. The following pictograms are taken from the Austrian web-based service SWIS as one deployment in compliance with this service description:

22 Level 1 could be merged with Level 2 to communicate only three levels towards the end users
23 Level 1 could be merged with Level 2 to communicate only three levels towards the end users
24 Level 1 could be merged with Level 2 to communicate only three levels towards the end users

Table 21: **Recommendations for common Look & Feel: Weather warnings, exemplary icons**

	Level of seriousness/probability			
Weather warnings	Level 0 (normal conditions) → "be prepared"	Level 1 (moderate conditions) → "drive carefully"	Level 2 (strong conditions) → "special attention needed"	Level 3 (extreme conditions) → "take action"
rain				
rain-flood				
extreme high temperature				
extreme low temperature				
thunderstorm				
fog				
snow/ice/slippery road surface				
wind				
flood				
avalanche				
forest fires				
coastal events				

3.5.2.5 ICT Infrastructure requirements

No specific requirement or advice

3.5.2.6 Required standards and specifications

Information provision standards:

- **IPS1**: **If the** Road Weather Information service provides Road **Weather Information** at **interface 1** (see IFR1), it **must** be profiled based on EN 16157-5:2020 using the DATEX II Recommended Service Profile for Road Weather information.
- **IPS2**: If interface 2 is implemented, Weather information regarding the in-vehicle signage of road signs (see IFR2) should be profiled in an IVIM (Infrastructure to Vehicle Information Message) based on ISO 19321 using the C-ROADS C-ITS Message Profiles for the In-Vehicle Signage service. Additionally, all other Weather information (see IFR2) **should** be profiled in a DENM (Decentralized Environmental Notification Message) based on ETSI EN 302 637-2 using the C-ROADS C-ITS Message Profiles for the Hazardous Location Notification service and the

Use-Cases Weather Condition Warning (WCW) and Temporarily Slippery Road (TSR), as defined in the C-ROADS Common C-ITS Service and Use Case Definitions.

— **IPS3**: When relevant, the Probe Vehicle Data (microscopic traffic situation) information (see IFR3) **should** be collected, which is profiled based on ETSI EN 302 637-2 using the CAR2CAR Communication Consortium Basic System Profile.

3.5.2.7 Level of Quality and Service Definition

3.5.2.7.1 Level of Quality criteria

The "Levels of Quality table" for the definition of quality criteria for RTTI and SRTI services, which differentiates data quality into "basic", "enhanced" and "advanced" (for detailed information see Quality of S Real-Time Services - Quality package) reflects the requirements for the data quality which are needed for Road Weather Information services. This table is not end-user oriented as Table 22.

Level of Quality advice:

— It is recommended that Road Weather Information services fulfil the "Basic quality level" as a minimum.

3.5.2.7.2 Level of Service Criteria

Table 22 gives the Level of Service recommendations for a Road Weather Information service. The background of this concept is descripted in chapter 2.6.

Table 22: Level of Service recommendations for Road Weather Information

Levels of Service criteria table: Road Weather Information			
Core Criteria	**A**	**B**	**C**
User interface* **(Language)**	One fixed language (all official languages)	Information available is capable of being provided in addition in a common and shared language.	Information available is capable of being provided independent of language
Neighbouring Provision**	No information exchange	Information exchange to neighbouring only	Neighbouring and beyond information provider exchange
Local and secondary Network***	No information (only information on TEN-T road network)	Exchange of information and use for strategic non TEN-T road network (key roads)	Additional information on local routes with impact on the TEN-T road network
Level of information	Weather Information	Level A + weather warning nowcast	Level B + weather warning forecast

Legend:
***User Interface:** This criterion relates to the interface between information and the user. Information should be capable of being displayed through pictograms (language independent) as an optimum, in an official language or an official language plus a shared language (English) as an intermediate level
****Neighbouring Provision:** Addresses the issue of information exchange and availability between Operators managing neighbouring network. Service providers dealing with several different sources
*****Local and secondary Network Information** (see LoQ for more details): Deals with provision of information relevant for non-TEN-T routes, provided on TEN-T routes.
******Level of Information:** Addresses the content to be provided by the service. Existing services distinguish between information and warning based on seriousness/ probability of an event.

3.5.2.7.3 Level of Service Criteria related to Operating Environment

<u>Level of service requirement:</u>

— **LoSR1**: In the case that pre-deployment surveys / evaluations provide the necessary evidence to proceed with the deployment of the ITS-service "Road Weather Information", the minimum and optimum LoS **should** respect the following Level of Service to Operating Environment mapping table.

Note: The Level of Service to Operating Environment mapping table is not an outcome of a specific scientific analysis but an expert view output.

Table 23: **Level of Service to Operating Environment mapping table (see also chapter 2.5.3 and ANNEX C)**

ROAD WEATHER INFORMATION SERVICES			Operating Environment													
Criteria for the Level of Service			C1	T1	T2	T3	T4	R1	R2	R3	R4	S1	S2	N1	N2	P1
User Interface	C	Information available is capable of being provided independent of language														
	B	Data available is capable of being provided in a common and shared language	O	O	O	O	O	O	O	O	O	O	O	O	O	O
	A	One fixed language (all official languages)	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Neighbour-ing Provision	C	Neighbouring and beyond information provider exchange														
	B	Information exchange to neighbouring only	O	O	O	O	O	O	O	O	O	O	O	O	O	O
	A	No information exchange	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Local and secondary Network information	C	Additional information on local routes with impact on the TEN-T (road network)	O													
	B	Exchange and use for strategic non TEN-T road network (key roads)		O	O	O	O	O	O	O	O	O	O	O	O	O
	A	Only information on TEN-T (road network)	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Level of information	C	Weather information and weather warning nowcast and forecast	O		O		O		O		O	O	O	O	O	O
	B	Weather information and weather warning nowcast		O		O		O		O						
	A	Weather information	M	M	M	M	M	M	M	M	M	M	M	M	M	M

Recommendatons for LoS per OE:

M	Minimum LoS recommended	O	Optimum LoS recommended
OM	Minimum = Optimum	NA	Non applicable

3.6 TTIS-05 Multimodal Travel Information Service

3.6.1 ITS service at a glance

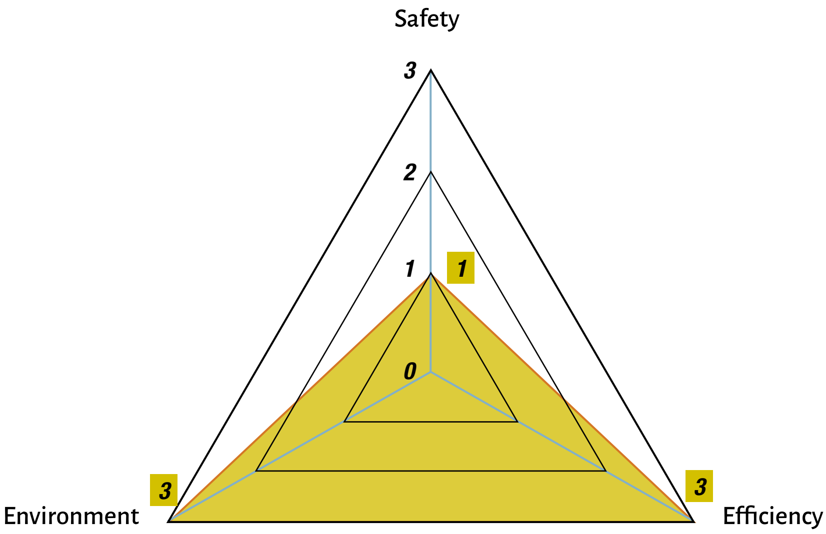
Service definition

Multimodal travel information services offer in parallel comparative information of different modes/means of transport (multimodal) and/or the combination of different modes/means of transport within the same route (inter-modal). The services offer information for at least public transport, car transport and usually pedestrian and bicycle transport.
The term multimodal is commonly used within the area of travel information services in the meaning of offering parallel information for more than one mode/means of transport. Inter-modal services offer in addition the combination of several modes/means of transport within one route.

Service objective

Multimodal travel information services can foster a modal shift towards reputed more environmental-friendly modes/means of transport and lead to a more efficient network operation as well as a better use of the transport infrastructure. The end users are enabled to select an appropriate and efficient mode/means of transport or a combination of different transport modes/means. Thus, the end users receive comprehensive information on alternative routes (including different means of transport) and the public mobility as a whole is facilitated.

Service benefit radar



ITS service key words

Multimodal, Modal shift, connected transport

3.6.1.1 ITS service strategy

3.6.1.1.1 General ITS service description

Multimodal travel information services offer in parallel comparative information of different modes/means of transport and/or the combination of different modes/means of transport within the same route. The services offer information for at least public transport, car transport and usually pedestrian and bicycle transport.

Multimodal travel information services require data from the different transport modes (road, rail, water- and airborne transport) from walking and cycling and from additional services such as parking.

The development of multimodal services has to be divided into **two general parts:**
- Data gathering, data processing and data transmission within the technical system of a multimodal travel information system itself, the "**back end system**" of the service.
- Processed data provision to user interfaces (e.g. Internet portal). This means that the processed data has to be transmitted in a certain format (e.g. xml) via a certain protocol and finally the data will be presented in the user **front end** interface.

Multimodal travel information services – back end system:
By entering travel demands (i.e. travelling from A to B within a certain time frame) on the Internet or on a mobile device the user receives multimodal information on travel options for road, rail, public transport, including if applicable water and air transport (including walking and cycling, e.g. to the first public transport stop on the route). The service normally includes pre-trip (and on-trip if available) public transport information as well as – if available up-to-date or predicted - road traffic information. Information given to the users can include: trip itineraries with predominantly static travel times; parking information/guidance; environmental impact; to a certain degree estimations of travel costs (e.g. for car traffic); and how to buy a ticket or book a service. The back end system combines all the different data sources to enable the comprehensive multimodal service provision as just described.

Multimodal travel information services – front end:
With the service of the front end, users interact directly and services of various carriers are provided via:
- PCs
- mobile devices
- in-car devices (radio, navigation systems)

Internet portals (websites) offer a well-structured access to multimodal travel information and trip planning. There are two major design options for such portals:
- User can be directed to Internet-sites with appropriate travel information via appropriate links (collection of links in one portal)
- The system integrates all multimodal information directly either[25]
  - by on-the-fly calculation on decentralized systems
  - by integration of different service providers` data into one database

25 see Delegated regulation EU 2017/1926, article 7 recommends linking of services.

Portals can offer Travel Information Services with static and/or dynamic data. Information can be given at regional, national and international level.

In the past years, the former separation of pre-trip and on-trip services has more or less disappeared through the development of services offered on smartphones and their growing penetration in the public.

3.6.1.1.2 What is the vision?

Multimodal Travel Information services can foster a modal shift towards more environmentally-friendly modes/means of transport and lead to a more efficient network operation as well as a better utilization of the transport infrastructure. The end users are enabled to select an appropriate and efficient mode/means of transport or a combination of different transport modes/means. Thus, the end users receive comprehensive information on alternative routes (including different means of transport) and the mobility service as a whole is facilitated.

3.6.1.1.3 What is the mission?

Currently a widespread patchwork of heterogeneous services exists across Europe. These services are partly operated by public transport companies, public authorities, but also private providers. Most services are limited to local or at most regional geographic coverage, which often corresponds to political and administrative borders and not necessarily to road user and traveller needs. These services are almost mature and are under a steady improvement process.

The multimodal service coverage on European level is mostly a blank area. Only few services exist at this level and are mostly operated by big private companies like Google or HERE Maps. However, there have been recent initiatives to define systems and services that link existing national system/journey planners into an European-wide service. For example, the European projects LinkingDanube[26] and LinkingAlps[27] have produced some significant results. Both projects developed and tested pilot implementations of multimodal, cross-border journey planning using interconnected national journey planners. The results of the projects provide a feasible solutions for linking of services, which is one of the key requirements of the MMTIS DR.

3.6.1.1.4 Distinctiveness to other ITS services

For the determination of a multimodal route it is necessary to apply data from different sources, in particular from data bases of traffic management systems, public transport data bases and parking data bases.

Furthermore, a geographic data base is required, which includes the entire road network as well as the public transport network with stops, lines and stations and parking facilities.

When providing a customer oriented MMTIS, it might be necessary to merge two or more of the core services in a modular way in order to better satisfy the end-users needs. The most important properties of a MMTIS are:

- Multimodal services should include travel time information: Travel time is of basic importance for the determination of the optimal route and most relevant information for the traveller. Multimodal route alternatives are usually compared by the corresponding travel times. The

26 http://www.interreg-danube.eu/approved-projects/linking-danube
27 https://alpine-space.eu/projects/linkingalps/en/home

current and the forecasted travel time of individual modes should be compared with each other for the trip to take into account the current traffic situation for the choice of transport mode.

— Multimodal services should include speed limit information: This information is normally used in a static way, i. e. given static speed limits in the road network are used to compute travel times, which are required for the determination of the best route. Dynamic speed limit information is usually not applied for multimodal services, especially as pre-trip information, but may support a more precise route calculation.
— Multimodal services compare the travel times for the different means of transport in a fair way. All travel times should be realistic for the relevant departure time and measured from door to door. For private cars in urban areas the time for parking and the footpath from and to the car could be included. Costs should also be displayed that arise of the change of transport (e.g. from individual to public transport), or e.g. when parking lots are recommended.
— Multimodal services should include real-time event information and warning services (incl. incidents): This information is applied in order to determine the optimal route and traffic modes for a given origin and destination under consideration of the current events, restraints and hazardous situations.
— Multimodal services should include traffic condition information: This information is needed in order to consider the current traffic situation and to compute travel times in a dynamic way.

3.6.2 Harmonization requirements and advice

3.6.2.1 Functional requirements and advice

3.6.2.1.1 Functional architecture

Figure 27 gives an overview of the interface architecture of Multimodal Travel Information service.

Figure 27: **Interface architecture of Multimodal Travel Information services**

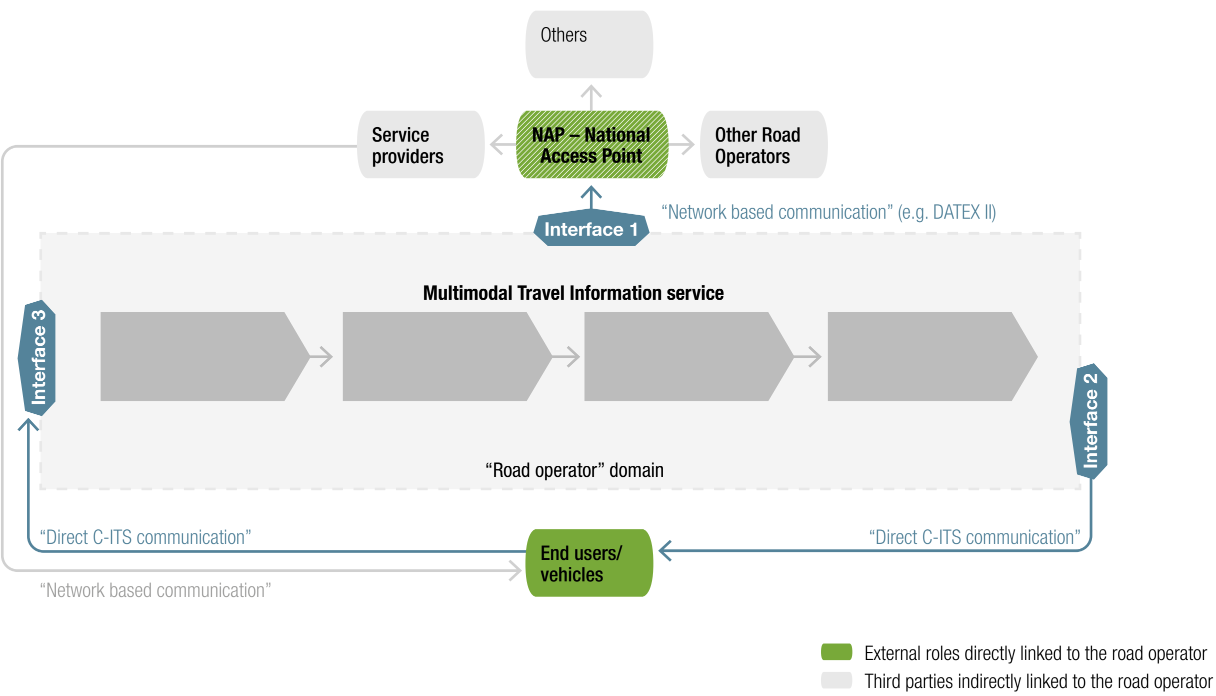
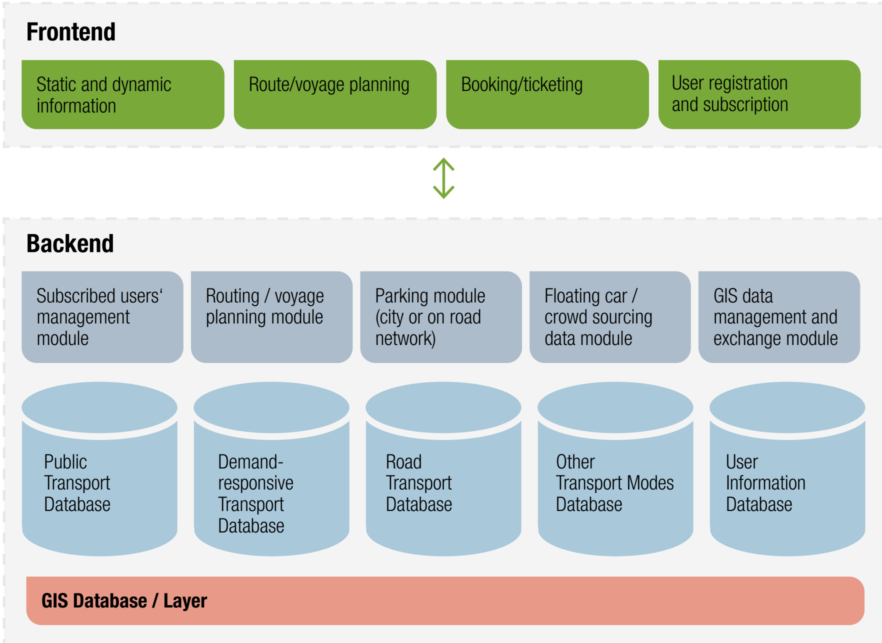


Figure 28 gives an overview of the functional architecture of Multimodal Travel Information service.

Figure 28: **Functional architecture of Multimodal Travel Information services**



3.6.2.1.2 Functional requirements and advice

Some of the components presented in Figure 28 have sub-modules as listed below:

- GIS Database / Layer:
  - GIS network description (city roads, pedestrian, cycle lanes, national road network etc.)
  - routing/voyage planning information (e.g. network graph with interconnection nodes, travel time and other "costs" [CO_2 emission, price etc] for each link between nodes)
  - static information on relevant nodes / POIs (bike/car sharing stations, Park & Ride stops, publicly accessible refuelling stations, parking places etc.)
- Public Transport database:
  - real-time information (vehicle position, arrival/departure times, occupancy, delays, disruptions etc)
  - ticketing data
- Demand-responsive transport database
  - real-time information (vehicle position, arrival/departure times, delays, disruptions, availability at a location etc)
  - ticketing/payment/booking data
- Road transport database
  - current road link travel times
  - road toll tariffs
  - future predicted road link travel times
  - disruptions
- Other transport modes databases
- User information database

  - where and how to buy tickets for scheduled modes, demand responsive modes and car parking
  - how to pay tolls
  - how to book car sharing, taxis …
  - etc.
- Subscribed users' management module
- Routing/voyage planning module
- Parking module (city or on road network)
  - parking spaces management
  - parking information
  - booking and payment
- Floating car / crowd sourcing data module
- GIS data management and exchange module

Functional requirements:

The following functional requirements are derived from Figure 28:

- **FR1:** Multimodal Travel Information **must** be based on a common or at least interoperable geographical reference model to be able to integrate different data sources which most likely use different location referencing methodologies and thus come to a common location referencing denominator.
- **FR2:** Multi-Modal Traveller Information and service platform **should** be based on a harmonised data model for each service feature. Service developer **should** orient the data model on already existing best practices.

3.6.2.2 Interface requirements

Interface requirements:

- **IFR1**: If the Multimodal Travel Information service provides data listed below at interface 1 (see Figure 26), it **should** provide coded information including the following elements.
  - static travel and traffic data and historic traffic data listed in point 1 of the Annex to the Delegated Regulation 2017/1926
  - dynamic travel and traffic data of different transport modes listed in point 2 of the Annex to the Delegated Regulation 2017/1926
  - routing / voyage planning results
- **IFR2**: If interface 2 is implemented, the Multimodal Travel Information Service **should** provide at interface 2 (see Figure 26) Multimodal Travel information coded in C-ITS messages for example the following elements:
  - road signs,
  - travel time information,
  - congestion information,
  - directions to suitable parking spaces or
  - modal shift advices to the public transport.
- **IFR3:** When implemented for C-ITS services, the Multimodal Travel Information Service **should** collect at interface 3 (see Figure 26) C-ITS coded Probe Vehicle Data information such as travel speed, direction, current location of a vehicle (microscopic traffic situation) relevant to this ITS Core service.

3.6.2.3 Organisational Requirements

Organisational Architecture/Business Model

A general overarching description of the key actors, their roles in the value chain and the related conditions for TTI service provision are outlined in Chapter 3.1. More information on new models of cooperation between public and private partners can be found in chapter 4.1.4.2

The following text interprets the four main organisational areas (organisation of the TTIS, obligations for TTIS provision, data used in the TTIS, business model of the TTIS) shown in Chapter 3.1.4 in relation to Multimodal Travel Information services requirements.

Organisation of the TIS

It is very important to distinguish between A.1 to A.5. These 5 categories show finally who is responsible for the service. For each of the five models from A.1 to A.5, the entity directly providing the service will be either private or public. However, for some models, the responsibility for the performance of the service is not clearly separated between private and public. For example in A.2 the provider is private but it acts according to its contract with the public entity. To enable OR2 and OR3 the following organisation is recommended:

Organisational requirement:

— **OR1:** The Multimodal Travel Information service **may** be organised according to the schemas A.1, A.2, A.3 or A.4 as shown in Figure 20.

Additional and/or added value services according to A5 schema should define recommendations to provide appropriate services.

Data used in the TTIS

Multimodal Travel Information services consist of different data sources. One can distinguish between data under public scope (C.1) which might be operated by private companies but on behalf of public, and data under private scope (C.3), for instance travel profiles from telecommunication companies or both, data under public and private scope (C.2).

Business model of the TTIS

Organisational requirements:

— **OR2:** Business models could be influenced by commercial considerations, which might lead to a preference of specific transport modes/means or other information content. This is one important reason that multimodal services **should** reflect a comparison of modes/means of transport not biased due to commercial motives.

— **Note:** Multimodal services aiming towards reducing private car use may integrate only some functionality dedicated to private car transport. In this case unbiased comparison is not relevant.

— **OR3:** Multimodal services according to A.1, A.2, A.3 and A.4 **should** be free of charge and non-commercial. Advertising respectively financing concepts with participation of the private sector are allowed as far as it is under public control and it does not lead to a preference of any specific transport mode or means of transport.

— **Note:** In some Member States the public sector is not involved directly in the service provision but is compiling and maintaining a transport information data base, which the private service providers (A.5) may use in any way they wish. In such cases the public sector supports private services (A.5) by maintaining all or part of the data bases utilised by the services but has no other role in service provision.

Furthermore, as most services consist of providing information only, it has so far proved to be difficult to create a business model for private service provision. However, it is possible that this situation might change and create a market for value-added services run by private operators. In any case, there should be a service available free of charge.

Transport operator obligation

A further important point is the need to regulate respectively oblige transport operators (e.g. private bus companies operating scheduled services, light rail franchisees etc.) to provide information in a common standardised format so as to enable multimodal journey planning services to be efficiently provided and reduce the not inconsiderable public funding required.

Organisational requirement:

— **OR5:** Public transport operators **may** be obliged by contract to provide their data in a format that is useful and defined by the public authority.

ITS directive (2010/40/EU)

Article 3 of the ITS directive (2010/40/EU) explicitly names the EU-wide provision of multimodal travel information services as priority area for the development of and use of specifications and standards. In priority areas the European Commission shall adopt the specifications necessary to ensure the compatibility, interoperability and continuity for the deployment and operational use of ITS. This includes “the definition of the necessary requirements to make EU-wide multimodal travel information services accurate and available across borders to ITS users, based on:

— the availability and accessibility of existing and accurate road and real-time traffic data used for multimodal travel information to ITS service providers without prejudice to safety and transport management constraints,

— the facilitation of the electronic data exchange between the relevant public authorities and stakeholders and the relevant ITS service providers, across borders,

— the timely updating of available road and traffic data used for multimodal travel information by the relevant public authorities and stakeholders,

— the timely updating of multimodal travel information by the ITS service providers (Annex I of the ITS directive).

Organisational requirement:

— **OR6**: Multimodal service providers **should** take into consideration the ITS directive (2010/40/EU) when developing services.

Delegated Regulation on MMTIS (EU 2017/1926)

The Commission Delegated Regulation EU 2017/1926 defines the necessary specifications to ensure multimodal travel information are implemented in a harmonized and consistent way across the EU. The Regulation lists service and data categories, service requirements and a phased implementation timeline per service categories.

Organisational requirement:

— **OR7:** Multimodal travel information service providers **must** take into consideration the Delegated Regulation on MMTIS (2017/1926) when developing services.

— **OR8:** Multimodal travel information service providers, transport operators and transport authorities **should** focus service implementation on the services and according to the timeline provided in the Delegated Regulation on MMTIS (2017/1926).

3.6.2.4 Common Look & Feel requirements

3.6.2.4.1 Preliminary remark

Most multimodal travel information services are designed for the world-wide-web. These internet applications developed their own user interface which is normally oriented at market leaders in the specific domains the service offers, e.g. map navigation oriented on market leaders. Public services must comply with the DIRECTIVE (EU) 2016/2102 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the accessibility of the websites and mobile applications of public sector bodies.

The following chapters are oriented on highly sophisticated services and market leaders and are the basis for the elaboration of multimodal services with a common look & feel.

3.6.2.4.2 Illustration of multimodal routing information on maps

The colours for the route indication in maps may be used as follows:

- Pedestrian: dark green
- Car: brown
- Bicycle: orange
- Subway: turquoise
- Suburban Train: bright green
- Tram: red
- Bus: blue
- Train: black
- Taxi: yellow

Common Look & Feel requirements:

- **CL&FR1:** Multimodal services **should** take into consideration the requirements for colour blind and other visually impaired people as far as possible.
- **CL&FR2:** Multimodal services **may** use the colours for means of transport route indication as listed above as far as these colours have enough contrast to the map background information.
- **CL&FR3:** Multimodal services **should** use different colours to indicate the different means of transport in maps.

3.6.2.4.3 Icons to illustrate the different map contents

The map presentation (only when the service offers this feature) is a main part of a Multimodal Travel Information service. MTTIS are very comprehensible services and the map presentation helps users among others to have a better orientation (in the sense of a geographical as well as a comprehensible transport relevant information orientation). This is also a reason to include so called POIs (points of interest) into the map presentation and also to use these POIs very often as predefined origins and destinations for multimodal routing services. Besides these POIs, many Multimodal Travel Information services show traffic relevant information (e.g. congestion warning, road closures etc.) in maps.

For the European citizen it is of high added value to harmonize the map presentation (icons used and also the colour scheme for route indication of different means of transport) of such comprehensible and thus also often very complex Multimodal Travel Information services. The users of these services will experience a much easier and understandable HMI when the map presentation respectively the icons are being harmonized.

Common look & feel requirements:

- **CL&FR4:** The display of signs/pictograms on VMS or other end-user devices **should** be in accordance with prevailing national road codes and:
  - Member States which ratified the Vienna Convention MUST respect the Vienna Convention and the European agreement supplementing the convention (1st May 1971) and SHOULD consider the Consolidated Resolution on Road Signs and Signals (R.E.2).
  - Member States which did not ratify the Vienna Convention SHOULD follow the Vienna Convention and also consider the R.E.2.
- **CL&FR5:** Icons **may** be categorized (e.g. in categories for travel information, public institutions etc.) and **may** follow a common colour scheme.
- **CL&FR6:** Icons **should** use internationally understandable designs and avoid country/region specific designs where possible/applicable.
- **CL&FR7:** Public transport icons for means of transport and public transport stops/stations **may** follow the local public transport operators design.

3.6.2.4.4 Presentation of multimodal travel information besides the map presentation

Common look & feel requirement:

- **CL&FR8:** Multimodal Travel Information services do not necessarily provide a map presentation. They might offer routing information and / or travel information besides maps in textual or a graphical way. This information provision **may** follow already existing services. The presentation of multimodal travel information besides the map presentation **may** follow already existing deployments.

3.6.2.5 ICT Infrastructure requirements

The requirements for the ICT infrastructure that supports the development and operation of Multimodal Travel Information Services can be divided into three sections:

- Road transport requirements
  - Traffic and road data-collection (including construction sites)
  - Monitoring of road and traffic status, including real-time influences on traffic (including incidents)
  - Calendar (holidays etc.)
  - Databases with road and traffic status
  - Databases for Parking (parking places, static and dynamic) and inter-modal exchange points
  - Comprehensive road network including footpaths and cycling facilities.
- Public transport requirements
  - Databases for Public Transport timetables, static
  - Basic Database for Public Transport which is geo-referenced on suitable geographical network. (stops, lines, etc…)
  - Dynamic Public Transport information (delays, cancellations, additional services etc.)
  - Updates of timetables
  - Day specific timetables
  - Departure time forecasts
  - Information at interchanges (interchange times, paths)
  - Route information
- Transport mode comprehensive requirements
  - Common or at least interoperable geographic reference

- Interfaces and protocols for data exchange, e.g. between different operators at national and international level
- Interfaces to mobile devices
- User-friendly user interfaces and maps

Technical requirements:

— **TR1:** Multimodal travel information services **should** offer at least information for public transport, bicycle transport, car transport and pedestrian.

The availability of world-wide-web technology and sufficient (broadband) connectivity is a basic requirement for most backend and frontend systems. It is likely that the mobile devices used for the service will also serve the purpose of data collection and reporting on incidents, delays and other relevant multimodal information.

Technical advice:

— Multimodal services should be based on transport mode comprehensive system requirements (see points above)

— Multimodal services aiming towards reducing car use may integrate only some functionalities of road transport.

3.6.2.6 Required standards and specifications

Multimodal Travel Information Services require the co-operation of actors from a wide range of different transport modes. The actors can be public and private.

Static data sources are required, e.g.: road/public transport network data, travel times, timetables for scheduled means of transport (short/long-distance), databases for evaluating environmental impacts of different means of transport/types of vehicle, maps. Also, suitable dynamic data can be used e.g.: road works, incidents, cancellations or deviations of public transport trips.

Information provision standards:

— **IPS1**: **If the** Multimodal Travel Information service provides multimodal traveller information at **interface 1** (see IFR1), it **should** be profiled conform the standards and initiatives listed below best fitting for their purposes. .

- Interoperable data models and standards for multimodal networks
  - GDF (just road network)
  - INSPIRE
- Interoperable data formats for dynamic location referencing with the focus for individual transport content:
  - OpenLR
  - TPEG-Loc
- Interoperable content modelling (data model, format and protocol) with road transport focus for dynamic data:
  - DATEXII
  - TPEG
- Interoperable content modelling (data model, format and protocol) with public transport focus for dynamic data:
  - SIRI
  - NeTEx
  - Transmodel

- Protocol and method to connect routing systems
  - DELFI
  - EU-SPIRIT
  - Open API for Distributed Journey Planning - CEN/TS 17118:2018
- Standardized protocols and methods to transfer map data and additional map information:
  - TN-ITS specification

— **IPS2**: If interface 2 is implemented, the Multimodal Travel Information (see IFR2) **must** be profiled in an IVIM (Infrastructure to Vehicle Information Message) based on ISO 19321 using the C-ROADS C-ITS Message Profiles for the In-Vehicle Signage service.

— **IPS3**: When implemented for C-ITS services, the Probe Vehicle Data (microscopic traffic situation) information (see IFR3) **should** be collected, which is profiled based on ETSI EN 302 637-2 using the CAR2CAR Communication Consortium Basic System Profile.

3.6.2.7 Level of Quality and Service Definition

3.6.2.7.1 Preliminary remark

The Operating Environment concept as defined in the Handbook cannot be applied to the MMTIS as it focusses very much on the TEN-T network, while MMTI services have a broader scope. Moreover, quality requirements for all MMTI services cannot be provided. The reason is that, because of the complexity of MMTIS, the EU EIP Activity 4.2, on which the quality concept of this Handbook is based, defined requirements only for a selection of the MMTI services referred to in the Service description.

3.6.2.7.2 Level of Quality Criteria

The “Levels of Quality table” for the definition of quality criteria for MMTIS services, which differentiates data quality into “basic”, “enhanced” and “advanced” (for detailed information see Quality of S Real-Time Services - Quality package) reflects the requirements for the data quality which are needed for Multimodal Travel Information services. This table is not end-user oriented as Table 28.

Level of Quality advice:

— It is recommended that Multimodal Travel Information services fulfil the “Basic quality level” as a minimum.

3.6.2.7.3 Level of Service Criteria

Table 24 gives the Level of Service recommendations for a Multimodal Travel Information service. The background of this concept is descripted in chapter 2.6.

Table 24: **Level of Service recommendations for Multimodal Travel Information services**

Levels of Service criteria table: Multimodal Travel Information Service			
Core Criteria	**A**	**B**	**C**
User interface* **(Language)**	One fixed language (all official languages)	Information available is capable of being provided in addition, in a common and shared language	Information available is capable of being provided independent of language
Neighbouring Provision**	No information exchange	Information exchange to neighbouring only	Neighbouring and beyond information provider exchange
Static/Dynamic	Static only	Static and partly dynamic	Static and dynamic
Legend: ***User Interface:** This criterion relates to the interface between information and the user. Information should be capable of being displayed through pictograms (language independent) as an optimum, in an official language or an official language plus a shared language (English) as an intermediate level ****Neighbouring Provision:** Addresses the issue of information exchange and availability between Operators managing neighbouring network. Service providers dealing with several different sources			

4

TMS - Traffic Management services

4 TMS - Traffic Management services

4.1 TMS-Introduction

4.1.1 Overview

This introduction provides an overview of the structure of Traffic Management Services and describes from different points of view aspects, which are common for all services of the whole spectrum of Traffic Management services. This introduction has been prepared to avoid repetition in the specific descriptions of the Traffic Management services.

As shown in Figure 29, the set of TM services comprises seven different ITS Core services, in particular:

- TMS-01 Dynamic Lane Management
- TMS-02 Variable Speed Limits
- TMS-03 Ramp Metering
- TMS-04 Hard Shoulder Running
- TMS-05 HGV Overtaking Ban
- TMS-06 Incident Warning and Management
- TMS-07 Traffic Management for Corridors and Networks

Figure 29: **Overview over all Traffic Management services and the relation to the TMS introduction**

In the following section, the profile and other important aspects of Traffic Management services are discussed in more detail:

- Purpose and aim of Traffic Management services
- Vision, Missions and Benefit of Traffic Management Core services
- The Traffic Management value chain

4.1.2 Purpose and aim of Traffic Management services

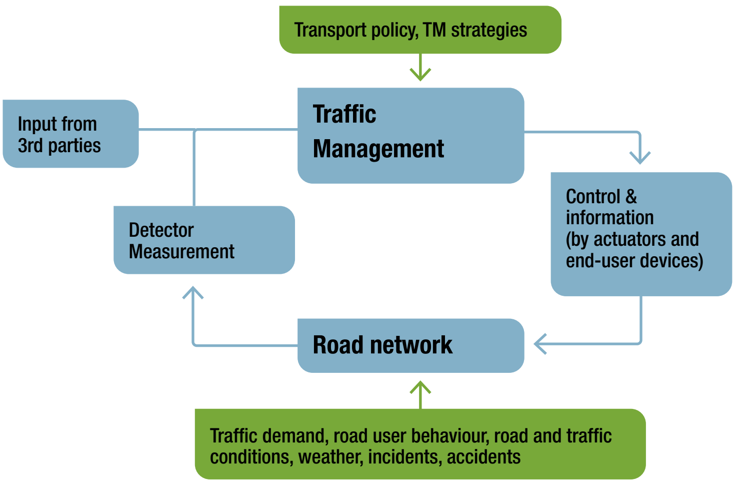
4.1.2.1 Introduction

Definition of "Traffic Management"
"Traffic Management" means the influencing of traffic through a bundle of measures in order to coordinate traffic demand to the existing traffic system supply to guarantee traffic safety at the highest possible level, to increase the efficiency of the network to the maximum possible and to reduce traffic-related environmental impacts as far as possible.

"Cross Competence Traffic Management" means that traffic situation is influenced by a bundle of measures in order to optimally coordinate the traffic demand and traffic systems supply beyond the borders of sovereign independently operating road operators optimally. These strategies include measures for the spatial, temporal or modal shift of traffic. In addition to the general objectives of traffic management, it is important to provide the road user with information beyond the limits of own responsibility.

Control loop "Traffic Management" as a principle
From a technical point of view, traffic management is based on the control loop principle, which is based in the theories of controlling technical processes A "control loop" serves to constantly counteract undesired setpoint deviations of a "controlled system" caused by external disturbance factors on the basis of previously defined operating rules and action guidelines.

Figure 30: **"Traffic Management" as control loop**



On the one hand, the state of the "controlled system" is continuously monitored and measured and on the other hand, the "controller" influences the system in such a way that it operates in accordance with the specified policy and rules when deviations on the monitored subsystems are registered. If this principle is transferred to traffic management, "road network and the traffic flowing on it" can be seen as the "controlled system" and the "Traffic Manager" is the controller, which is supported by fully or semi-automatic, traffic-dependent decision-support or even fully automatic Intelligent Traffic Systems (ITS).

The traffic manager uses systems and technologies which are capable of influencing the behaviour of road users. This requires a range of field devices (detectors/sensors) to measure the actual traffic and weather circumstances in the controlled system, a software-based process (centralised or distributed) that may involve human actions, the transmission of information to road users by means of signals, traffic signs and barriers.

By their nature Traffic Management services can be divided into two categories.
- Control services (TMS-01 to TMS-05), which purpose is to respond to events that can be precisely localised and which can be operated by a road operator alone,
- Management services (TMS-06 and TMS-07), which are aiming at eliminating or mitigating problems of the incidents that effect greater part of the controlled network and that require the cooperation of more than one road operator.

4.1.3 Vision, Missions and Benefit of Traffic Management Core services

4.1.3.1 What is the Vision?

Traffic Management Services are primarily aimed at three goals (separately or in combination)

- Increasing traffic safety to prevent accidents
- Improving the performance or optimising the use of existing network capacities
- Mitigating the negative environmental effects of traffic

4.1.3.2 What are the Missions?

The Traffic Management services have specific missions to ensure safe driving and utilize the available road capacity in a optimal way. The real-time management monitors traffic flow and driving conditions to identify expected or unexpected events or incidents to make needed control measures to fulfil its missions.

In summary and as an overview, each Traffic Management service pursue the following specific objectives

TMS-01 Dynamic Lane Management (DLM)

- optimizing the capacity of existing roads by using dynamic devices that affect vehicle flow by assigning the number of lanes that are open or the types of vehicles which are authorized,
- achieving a temporary clearance of lanes in case of accidents, incidents, road maintenance work or road construction measures (safeguarding of lanes),
- allocating lanes on black spot areas (bridges or tunnels) or at locations with poor safety records.

TMS-02 Variable Speed Limits (Speed Control)

- harmonising traffic flow,
- increasing traffic safety by alerting and slowing down traffic approaching road works and incidents locations,
- adapting drivers speed dependent on road and weather conditions like rain, slippery roads or constricted visibility,
- mitigating the negative environmental effects of traffic,
- helping to protect vulnerable road users.

TMS-03 Ramp Metering

— preventing or delaying the onset of flow breakdown on the main carriageway, maximising throughput, without disrupting the urban road network.

TMS-04 Hard Shoulder Running

— creating a dynamic extra lane triggered by traffic demand, at fixed times (peak hours) or even manually in case of bottlenecks/problem areas in the network with recurrent, but not constant, lack of capacity, i.e., recurrent peak hour congestion,
— providing extra capacity for a dedicated set of road users (i.e. public transport vehicles).

TMS-05 HGV Overtaking Ban

— reducing travel time and increasing safety for passenger vehicles by avoiding queues caused by slow lorries overtaking and unexpected lane changes,
— reducing CO_2 emissions,
— ensuring a better coexistence of heavy goods vehicle drivers and the other road users.

TMS-06 Incident Warning and Management

— creating the safest possible workplace at the scene of the incident to ensure the safety of Incident management responders and road users (upstream of the incident and on the other side of the road) to mitigate additional risks, i.e. secondary incidents.
— diverting traffic via other routes to relieve the incident area and safeguard the mobility of traffic flow in order to reduce delays and increase reliability for the road user,
— considering the consequences, including the economic cost incurred, of the 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. guard rails) and civil engineering structures),
— minimising the economic damage (vehicle loss hours) of incidents.

TMS-07 Traffic Management for Corridors and Networks

— informing road-users in real-time and providing a consistent and timely service to the road user in case of unforeseeable events (incidents[28], accidents) or predictable events (recurrent or non-recurrent) providing seamless, language independent and consistent cross-border and traffic management and traveller information,
— considering the network as a whole to optimise the use of existing road infrastructure capacities

More detailed information on the objectives of the Traffic Management Services can be found in chapters 4.2 to 4.8.

4.1.3.3 What is the contribution of TM Core services to overarching European ITS objectives?

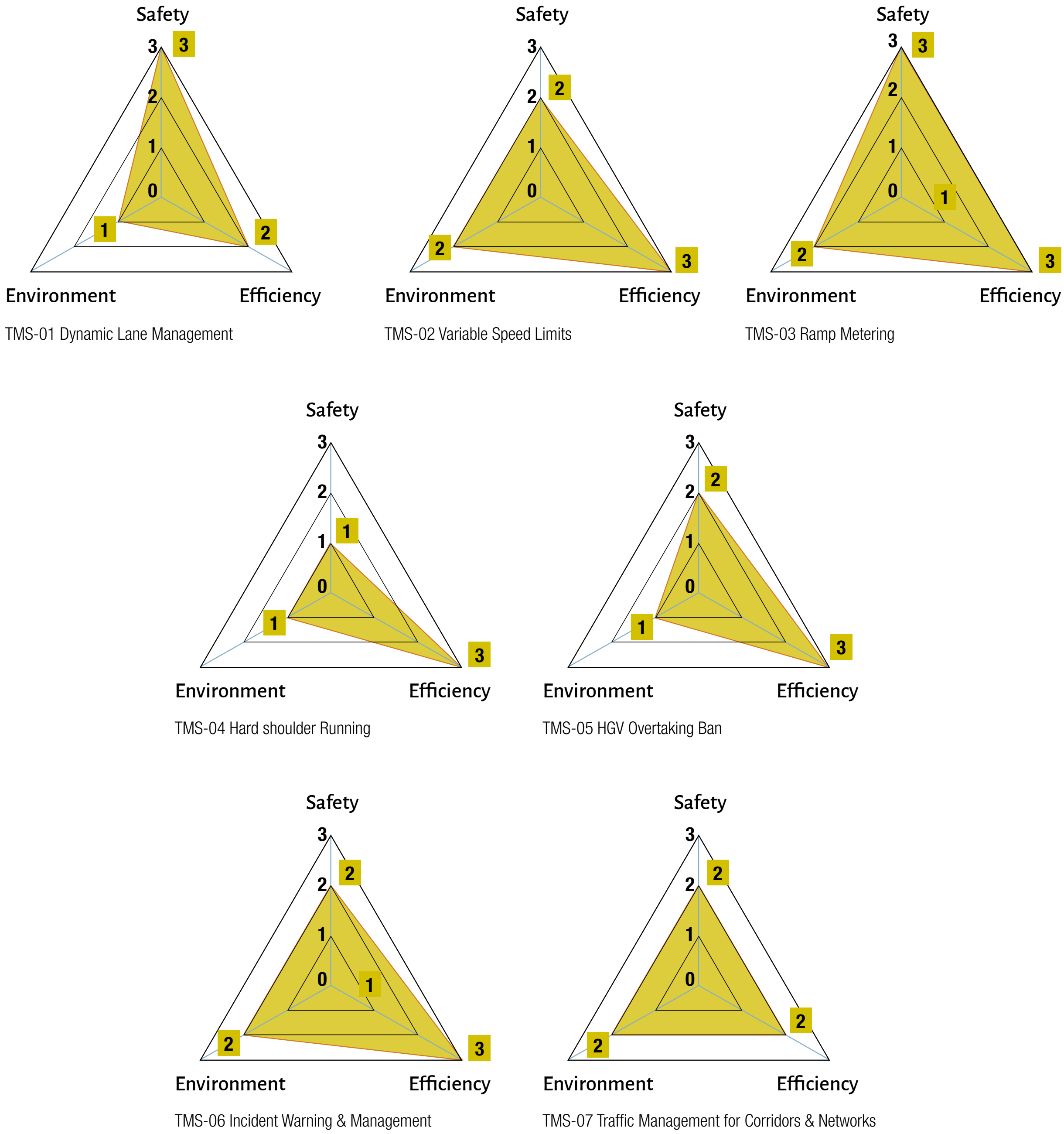
4.1.3.3.1 Overview

Figure 31 presents the Service Radar diagrams for the Traffic Management ITS core services of the handbook. As shown in the radar diagrams, the main benefits delivered by TM Core services relate to safety and efficiency. Their specific effects are discussed in more detail in the following section.

Note: As already mentioned in chapter 2.3, the Service Radars of the various services are not in relation to each other and not directly comparable.

28 **Incident**: situation on the road that is not expected or foreseen which may or may not lead to an accident (collision) but impacts on the safety and/or capacity of the road network for a limited time period.

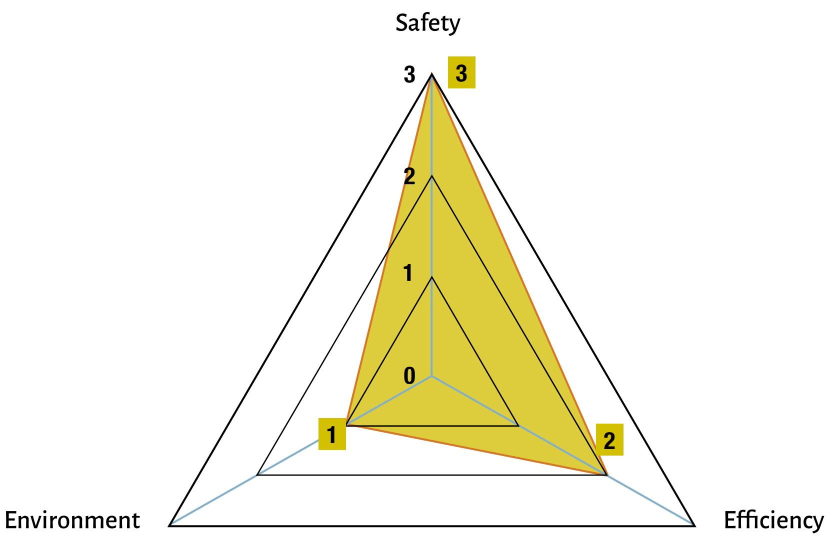
Figure 31: **The Traffic Management service radars**



4.1.3.3.2 ITS service radars in detail

Dynamic Lane Management

Figure 32: **Service radar «Dynamic Lane Management»**



Safety
In most cases, Dynamic lane management (DLM) enables the temporary, demand-responsive capacity increase of sections (working sites and incidents are exceptions). Since a better distribution of traffic in the road section is possible by raising the number of lanes, the following behaviour can be better adjusted and the danger of accidents can be reduced. The impact analysis of comparable systems confirms the positive effect on traffic safety. Moreover, some DLM measures are clearly safety-oriented: lane allocation before and in tunnels, lane allocation due to incidents / accidents and lane clearing ahead of working sites. In literature, reductions in the number of accidents have been observed and range in most cases between 15% and 45%, with the reduction in some cases even exceeding 50%.

Environmental impact
Systems for dynamic lane management (DLM) have positive effects on the traffic flow and reduce traffic-related congestion and accidents (followed by further congestion). By means of traffic smoothing, noise and pollutant emissions are reduced. In literature, a reduction ranging from 3-10% for various pollutant emissions (CO_2, NOx, CO, …) is reported.

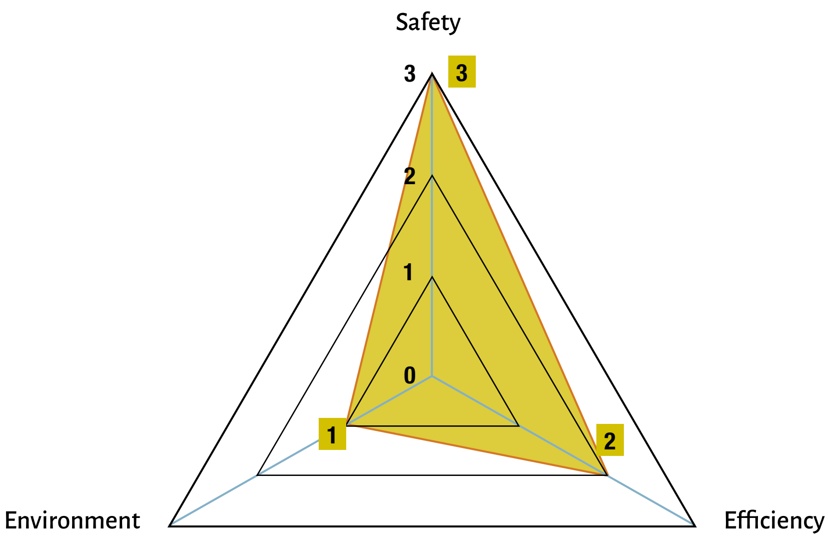
Network efficiency
A demand-oriented increase of the capacity on route sections and at junctions clearly results in an improvement of the traffic flow in the whole network area concerned. Also, in case of incidents, the lane allocation helps keeping the traffic flow fluent by closing lanes and directing traffic to unblocked lanes. In particular, it has been proved that the number of accidents and their frequency decrease where the dynamic management of lanes is planned and activated properly. From the point of view of users, this also contributes to a more regular traffic flow (due to a better use of road capacity) and to a reduction of travel time losses.

Variable Speed Limits

The common main objectives of VSL is both to support drivers in travelling at a safe speed and to have less interrupted traffic flow. In some cases, speed limits are also used to mitigate environmental effects, such as noise or pollution.

The service radar indicates the general expected impact of the implemented VSL systems. On a specific implementation, however the outcome may be very different from the general results, because the system are designed from the problem-oriented point of view. Essential things in implementing a VSL system are the main effects the system are designed for and what are the parameters that are used for the control of the system. The control parameters may be road and weather conditions for safety or traffic flow information for efficient use of road network.

Figure 33: **Service Radar "Variable Speed Limit"**



Safety

The deployment of speed control offers an opportunity to improve traffic safety by using information for example about traffic flow, road and weather conditions, roadworks or unexpected incidents. Traffic volume-related and/or weather-related speed control reduces the risk of congestion and accidents. The impact analysis of existing implementations confirms the positive effect on traffic safety.

In the NEXT ITS literature research, an average reduction of 8% of both fatal and accidents with injuries is reported. Some additional highlights from the literature are provided below:

— In a Danish study, accidents are found to be reduced by 50%, however in a short observation period of one year after implementation.

— In Swedish studies summarized in the 2DECIDE toolkit, an evaluation of accidents considering a time period covering two years before and two year after implementation revealed a reduction of accidents by 20%. Another evaluation of a road weather controlled VSL implementation in Sweden, also summarized in the 2DECIDE toolkit, showed a reduction of fatal accidents by 40%.

— In a Dutch study evaluating implementations in the Tilburg area, a limited positive effect has also been observed.

— In an implementation in France, a reduction in the total number of accidents and victims of 25% with a strong decrease in the severity of accidents was observed.

— In an URSA MAJOR 2 implementation in Switzerland, no impact on safety was observed. This was attributed to the fact that evaluations on safety require an adequately long time period for observations, which in that case was not available. However, another implementation in the MedTIS Corridor showed a slight decrease of accidents in the first year but an increase in the following two years.

Environmental impact

VSL systems on motorways positively affect the traffic flow and reduce traffic-related congestion and number of accidents (and the consequence of further congestion development). Improving the traffic conditions and having more uninterrupted traffic flow, also reduces noise and pollutant emissions.

VSL can also be used for environmental purposes only, with a reduced speed limit to mitigate noise and emissions when there is no congestion. This practice is also common in urban areas as well. In a Dutch study evaluating implementations in the Tilburg area, a reduction of NOx emissions of 18% was observed.

VSL system can also be used to increase the speed limit during low traffic demand periods to increase the level of service. In these cases, the VSL system can also have negative environmental effects.

Network efficiency

Traffic demand-oriented speed control improves the traffic flow efficiency in the complete network area concerned. The duration of congestion is shorter, and the loss in vehicle operating and time costs is considerably reduced, as the capacity of existing road section is optimally used utilizing VSL. On motorways, traffic flow is more stable and has greater capacity after the VLS system is introduced.

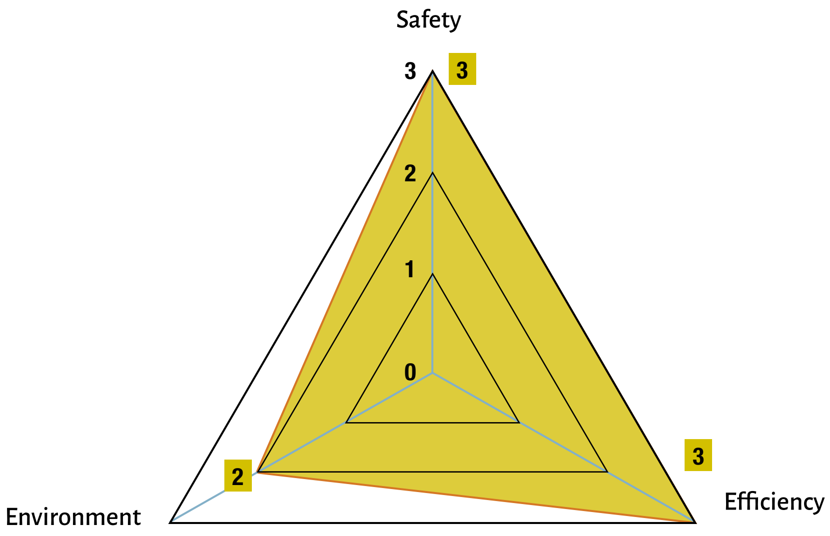
Variable speed limits seem to be effective means for handling congestion and growing queues especially where the speeds tend to suddenly fall dramatically. The introduction of VSL in Mölndal and Tingstadstunneln has led to an increased average speed and 15 % shorter travel time on average (Results from the previously mentioned Swedish studies summarized in the 2DECIDE toolkit). Results from Denmark indicate a reduction of average travel times in the morning and afternoon peak periods ranging from 3-17%.

Ramp Metering

The main benefits of the service is achieved by:

— Improved merging behaviour and less lane changing leads to a reduction in accidents
— Increasing mainline traffic speed, reducing congestion and making travel times more reliable
— Smoother traffic flows can lead to a reduction in emissions

Figure 34: **Service Radar "Ramp Metering"**



Safety

Improvement in the merging behaviour of traffic has a positive impact on traffic safety due to less lane changing. The breakup of merging slip road vehicle platoons reduces the incident and congestion potential on the main carriageway as well as the frequency of accidents. The long-term impact analysis of existing and comparable ramp metering systems confirms the positive effect on road safety due to the confirmed drop in the number of recorded accidents. Overall, crash reductions ranging from 5% to 40% are reported in literature. Rear-end and sideswipe crashes benefit the most from this service.

Environmental impact

It is believed that smoother traffic flow resulting in less speed variation on a metered motorway can lead to reduction in emissions and fuel savings. This is also the outcome of most evaluations in literature, while feedback from the experts during the external review phase also confirms the environmental benefits of the service. However, a few studies have found increased fuel consumption and emissions following ramp metering implementation. Some example evaluation results on the environmental impact of ramp metering are provided below:

— Overall, the literature review of NEXT ITS reports results ranging from a reduction of 9% up to an increase of 4%.
— In France, field tests of various control strategies measured a reduction of fuel consumption between 5-8%. Emissions were found to decrease respectively. Specifically, the HC and CO indices were reduced by 6-9%.
— In the Netherlands, a study from Delft reports a measured reduction of emissions by 2%. However, other studies from the Netherlands even indicate an increase of emissions between 1-4%.

Network efficiency

Network efficiency impacts include the reduction of network travel time variability and increased throughput by eliminating the stop-go behaviour associated with congestion. Ramp metering significantly improves the traffic flow on the main carriageway therefore reducing travel times/costs and operating costs. There are several studies related to the impact of ramp metering on traffic flows:

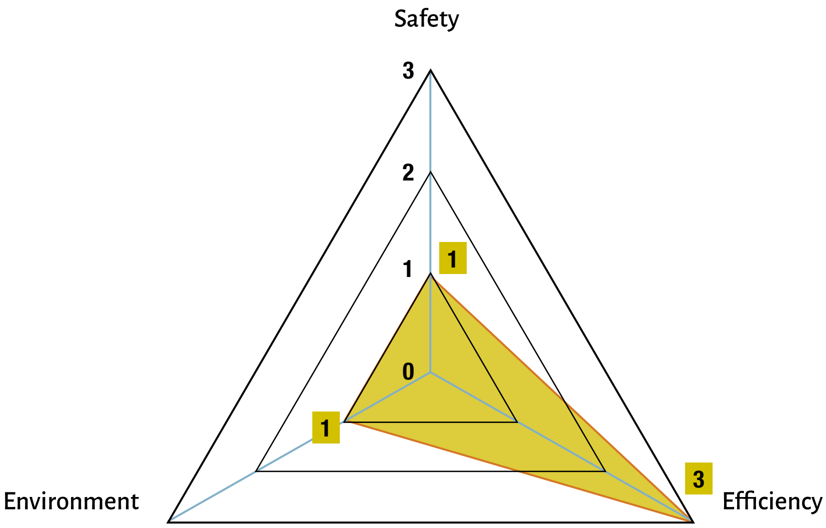
— In Germany, traffic speed increases of up to 35% and up to 50% less congestion were experienced.
— The UK Highways England found that the overall increase in peak period traffic flows observed on the mainline after the installation of ramp metering varies by site with individual increases in traffic flow ranging from 1 – 8%. Despite the increases in traffic flow the implementation of ramp metering has resulted in downstream traffic speed increasing by between 3.5% and 35%.
— Highways England found an average journey time saving for mainline traffic of 13% across all sites evaluated. The average on-ramp delay per vehicle with ramp metering operational ranged from 15s to 78s, however the sites with the highest delay on the on-ramp in general also delivered the highest benefit on the main carriageway.
— In the Netherlands an increase of capacity of 0-5% has been measured, with an average of 2% speed on the main carriageway showed increases in the range of +4 km/hr to +30 km/hr.
— The EURAMP Project impact analysis found ramp metering could improve Total Time Spent (TTS) in the system; this includes time on motorway, on ramps, travelling and waiting time.
— In France, field tests of several control strategies were carried out with positive results compared to the "no control" scenario: Mean speed increased between 5-12% and time spent in the network decreased by 10-12%.

Detailed evaluation results from several sites and testing various algorithms can be found in the European Ramp Metering Project EURAMP Deliverable 6.3.

Hard Shoulder Running

The main benefits of the HSR service are achieved by:
— Increasing capacity on the network by opening an extra lane, and in most cases varying the maximum allowable speed which together has the effect of improving the efficiency along the section of road where the scheme is implemented.
— Reducing number of lane changes, increasing headway and reducing speed which leads to a reduction in accidents.
— Smoothing the flow of traffic which can lead to a reduction in emissions.

Figure 35: **Service Radar "Hard Shoulder Running"**



Safety
Hard Shoulder Running enables the temporary, demand-responsive capacity increase of road sections. This results in a better distribution of traffic by allowing road users to adjust more easily to dangerous situations and results in reduction of accidents due to the decrease/elimination of (upstream) congestion. The use of Hard Shoulder Running implies a decrease in the accident rate overall if the infrastructure has been significantly adapted for its use. In general, the impact analysis of comparable systems confirms the positive effect on traffic safety.

Note: However, Hard Shoulder Running may have negative impacts on safety, for example when broken-down vehicles need to stop. To avoid this, HSR sections have to be monitored and controlled and the operator's response to such a situation has to be as fast as possible. In addition, due to the safety advantages of a closed hard shoulder, it is advised to use the service temporarily, when the need for extra capacity arises.

Environmental impact
By providing extra capacity, Hard Shoulder Running systems reduce congestion and journey times. This improves the efficiency of journeys and reduces the pollution generated by each journey. Indicative results from literature show a potential reduction of 4-8% of pollutant emissions (CO_2, NOx) and 6-10% of PM10.

If traffic flows do not increase, emissions are likely to be reduced. The increased capacity of the motorway could attract more users and lead to an increase of emissions locally. However, from the perspective of the corridor/network, if the motorway with Hard Shoulder Running attracts traffic from alternative routes, e.g. local roads, an increase in traffic flow on the motorway might not be negative for the environment.

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

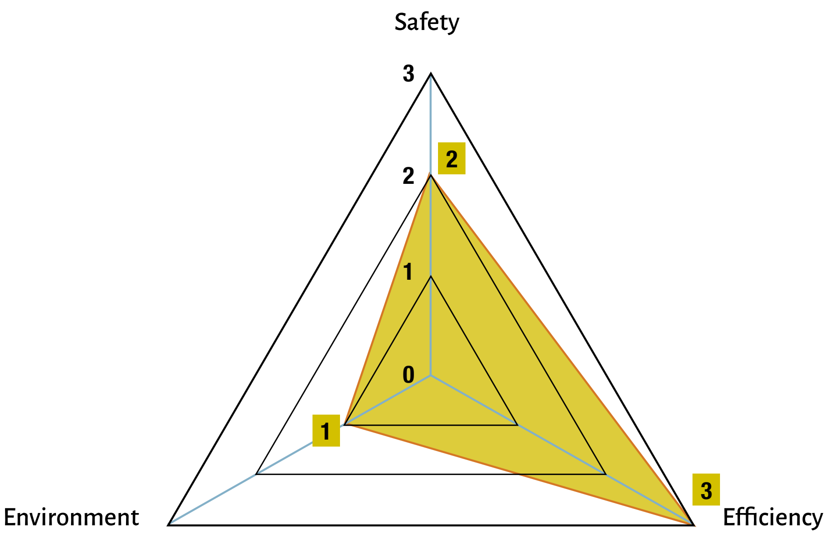
The impact analysis of comparable systems confirms the positive effect of Hard Shoulder Running on network efficiency. Results from implementations on the URSA MAJOR and Arc Atlantique Corridors show a reduction in travel time of at least 8%, capacity increases between 9-19% and reduction of congestion events by 24%.

Finally, it can be noted that compliance of the road user is another relevant aspect of network efficiency. Under-utilisation of the hard shoulder lane by the users decreases the effect of the measure.

HGV Overtaking Ban

Network efficiency and safety are assessed as the main benefits of the HGV Overtaking Ban service.

Figure 36: **Service radar "HGV Overtaking ban"**



Safety
The previous deployments of HGV overtaking bans have demonstrated safety improvement. This is particularly accurate on sections where the percentage of accidents due to a high level of lorry traffic is high.

One additional major impact of this measure concerns the psychological comfort brought to car drivers. Investigations in some countries show that dynamic overtaking bans for HGVs (concentrated on peak hours) provide considerably better results than static overtaking bans for HGVs.

Environmental impact
Improved network efficiency and network management help to reduce vehicles' emissions. This is also observed in practice. For example, following the French experimentation of this service on ASF network during summer 2007 peak traffic periods a decrease of polluting emissions was recorded (-500 tons of CO2) due to the congestion drop (-7%).

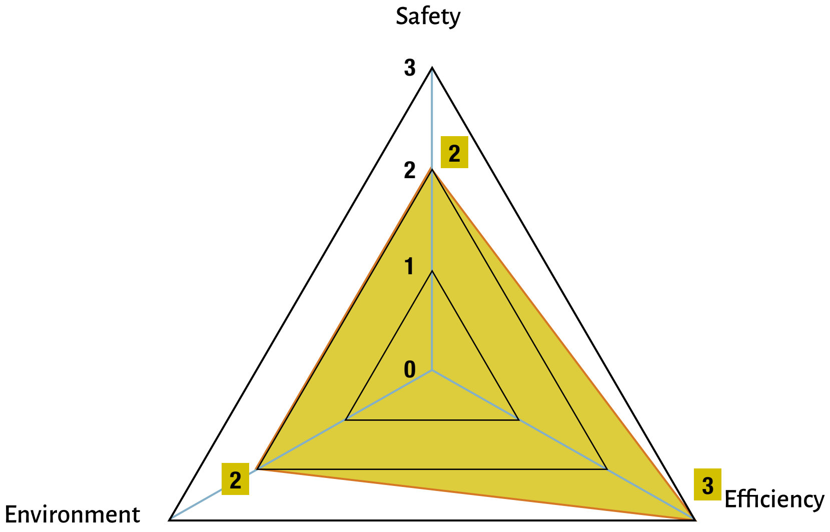
Network efficiency
An HGV overtaking ban positively impacts the network in terms of efficiency. The existing deployments and evaluations show:

- A speed homogenisation on each lane,
- An average speed increase on each lane in the case of light traffic (< 2000 veh/h for 2 lanes),
- An increase of light vehicle speed in the case of heavy traffic (> 2000 veh/h for 2 lanes),
- A decrease of traffic jams during peak traffic periods.

The service contributes to optimise the use of the network, especially on sections where the percentage of HGV traffic superior to 10%. This potentially concerns a substantial part of the TEN-T Road Network.

Incident Warning and Management

Figure 37: **Service radar "Incident Warning and Management"**



Safety
The application of measures for Incident Warning and Management offers the opportunity to optimize road safety where dangerous situations occur suddenly. Quick reaction on incidents contributes significantly to the prevention of secondary incidents. Based on data from MedTIS, secondary incidents consist 4-12% of the total number of incidents and a timelier reaction on incidents was found to reduce overall incident numbers from 1,6%. Therefore, this service contributes to a significant reduction of especially secondary incidents. Results from the NEXT ITS literature research report a similar overall reduction of accidents.

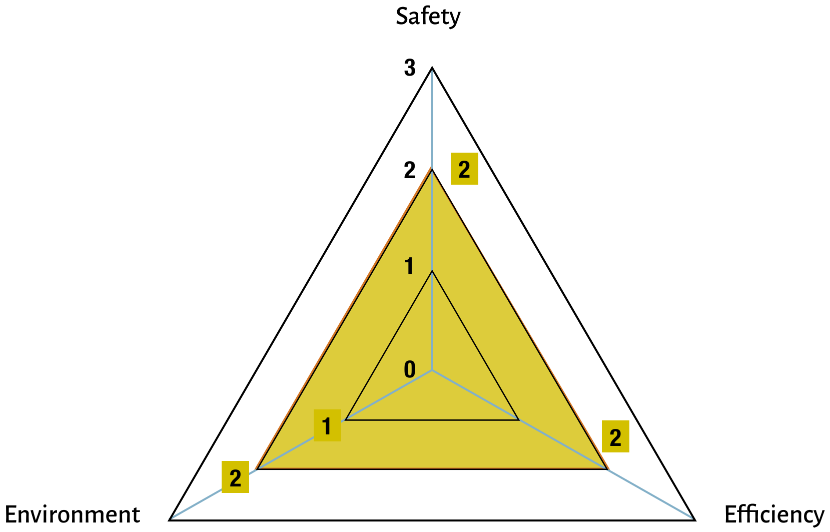
Environmental impact
The service has a significant impact on polluting emissions, mainly through its high impact on network efficiency, reduction of congestion and secondary incidents.

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. Furthermore, effective incident warning and management can reduce congestion in relation to accidents on the road by optimizing clearing processes, paying attention to leading traffic past or around the scene of the accident and giving drivers on the way towards the accident an opportunity to choose another route or even drive later in case of a motorway closing. This can significantly reduce the level of congestion, delay and cost due to these negative factors, including costs associated with asset restoration.

The NEXT-ITS literature research for this service has concluded to an average reduction of approximately 10% in vehicle congestion hours and 2% in vehicle hours driven achieved with efficient incident management. This identified significant impact on network efficiency is also in line with experiences submitted during the external review phase.

Traffic Management for Corridors and Networks

Figure 38: **Service radar "Traffic Management for Corridors and Networks"**



Safety
Timely and effective measures in case of major incidents serve to mitigate safety impacts. The quick and consistent provision of traveller information such as "Forecast and Real Time Event Information" (see 3.2) and "Incident Warning and Management" (see 4.7), as a part of the TMP measures, contribute to safety by warning travellers to reduce their speed.

Environmental impact
Reduction of environmental impacts due to re-routed vehicles can be estimated, if the additional length of the alternative route is appropriate to the congestion length. TMPs are also highly relevant in order to improve air quality in cities, e.g. by traffic information or traffic management measures.

Network efficiency
The main benefit in terms of network efficiency is the reduction in delays and travel time through the use of effective and timely control and information measures in the case of major incidents. Within TMPs not just the disrupted road section but the whole surrounding network (and sometimes even other transport modes) should be considered. This ensures a more efficient use of existing traffic infrastructure.

4.1.4 The Traffic Management Value Chain

4.1.4.1 Functional architecture and interfaces

The TISA Value Chain Model

Traffic Management means value creation for road users. Planning data, traffic-relevant messages on traffic-related events and real-time traffic data are refined into information that creates added value for travellers. Gathered information can serve as a sound basis for decision-making processes in Traffic Management systems.

Figure 39: **The Traffic Management value chain (basic model)**

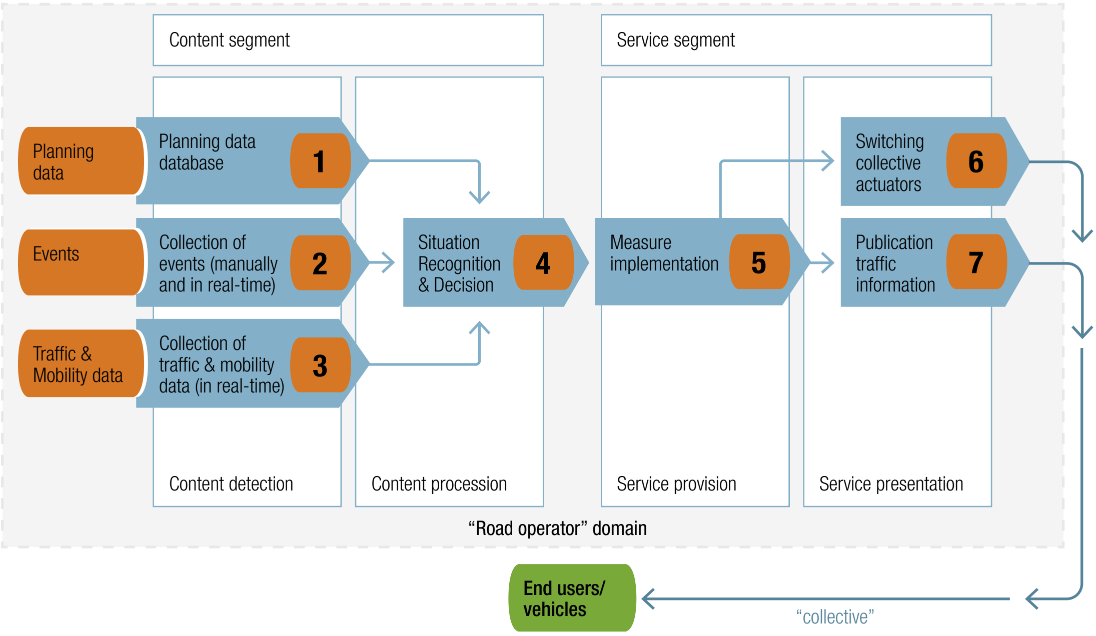


Figure 39 shows the approach of the basic value chain model for Traffic Management on the public road operator's side, based on the "TISA Value Chain Model". Traffic Management processes the gathered data and creates additional value of data using decision making mechanisms.

- On the left side of the figure the content segment with the so-called content detection (collection) and content processing is shown. Event messages (2) and real-time traffic data (3) are constantly monitored on relevant Traffic Management network segments and interpreted as traffic situations. If predefined threshold values are exceeded, this creates a predefined situation (4) identifiable in the planning database (1).
- On the right side of the figure the service segment is shown. The action instruction linked to the identified situation is implemented in the form of one or a bundle of individual measures (5). On the one hand these consist of the switching of the available actuators of the road operator for traffic control and traffic guidance (variable messages sign or information display, traffic lights, P+R signs...) (6) and on the other hand the accompanying publication of relevant Traffic Management information on (mobile) Internet (applications) (7).

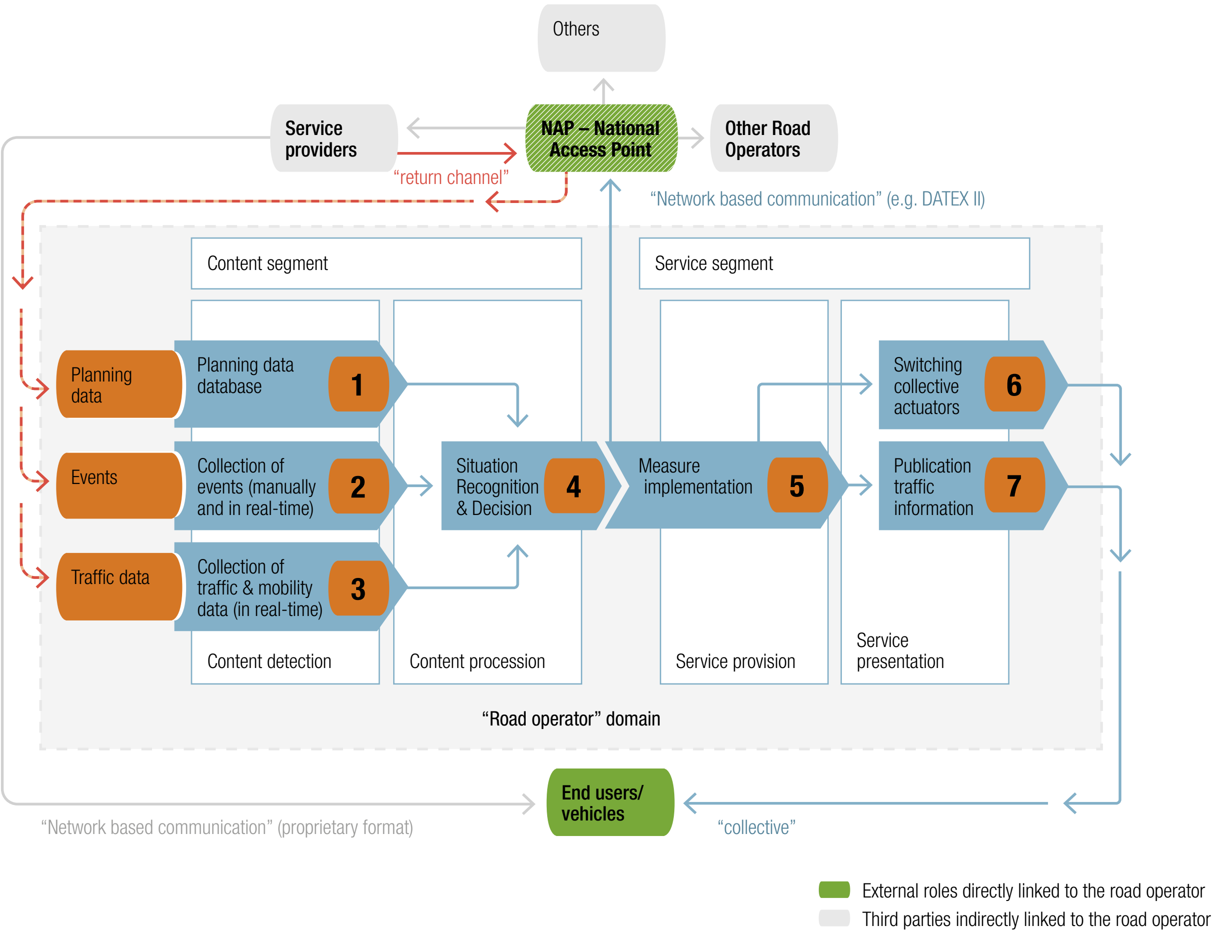
Extensions of the TISA Value Chain Model

Mainly driven by the European Directive 2010/40/EU, to find a response to the increase in the volume of road transport to the growth of the European economy and mobility requirements of citizens, that cause increasing congestion of road infrastructure and rising energy consumption, as well as environmental and social problems, the ITS value chain has been significantly extended by opening it up to private service providers and by applying new C-ITS technologies.

Extension of the TM Value Chain according to Delegated Regulations of the European Commission

Figure 40 shows the current form of the ITS value chain, which is based on the obligation of the European Delegated Regulations to provide digitally available traffic and travel information at the National Access Point.

Figure 40: **The Traffic Management Value Chain (with NAP-model)**



Driven in particular by the Delegated Regulations of the European Commission:
- (EU) 886/2013 of 15 May 2013 on “the provision, where possible, of road safety-related minimum universal traffic information free of charge to users”,
- (EU) 2015/962 of 18 December 2014 on “the provision of EU-wide real-time traffic information services”,

and the associated requirement to introduce so-called National Access Points (NAPs) as well as to use DATEX II profiles for data exchange, the value chain of public road operators went through a significant expansion (see Figure 40).

Since the Delegated Regulations came into force, European road operators are obliged to publish digitally available information on the NAP. This is the first time that such data and information should be made publicly available outside the domain of public road operators and can be used by (private) mobility service providers, for example, but also by other road operators for their own purposes. With regard to traffic management, this information obligation applies to the information outcome of measures and actions to be taken as a result of a Traffic Management decision.

Appropriate DATEX II profiles for data exchange with the NAP are defined in the CEN/TS specification 16157- 8:2020.

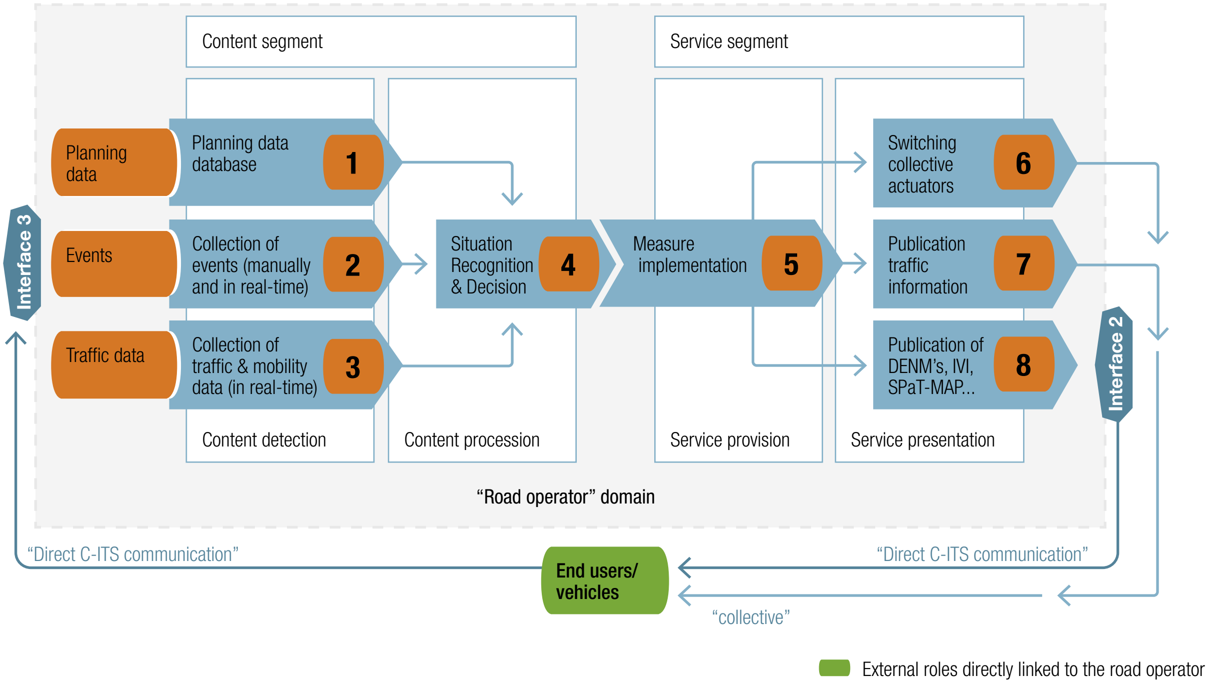
As Traffic Management services usually use Variable Message Signs (VMS) installed at the roadside or overhead, thus, additionally and in parallel, the corresponding information can be published via the National Access Point for the use of private service providers or other road operators.

A possible extension of the NAP-functionality and an added value for the traffic management value chain is the so-called “return channel” (see patterned red arrows in figure 40). The aim of this extension is to provide public road operators with information about the driving or mobility behaviour of individual customers of the service providers, which they cannot obtain with their own means of real-time data and information detection.

Extension of the TM value chain according to C-ITS

The value chain for Traffic Management is further extended by new cooperative technologies (C-ITS), as they are now being piloted and deployed in the European cooperation project C-ROADS. As already described in the generic interface implementation model (chapter 2.5.1), it adds two interfaces (2 and 3) on the short range (see Figure 41). The transmission of C-ITS messages via established cellular communication follows the network based communication path as illustrated in Figure 40.

Figure 41: **The Traffic Management Value Chain (with short-range C-ITS facilities – the cellular C-ITS messages are transmitted as the Network based communication in Figure 40)**



The aim of this extension is to enable the road user to be reached directly without distraction. Through C-ITS warning services like Traffic Jam Ahead or Road Works Warning. Messages can be sent to the appropriate road user and help to avoid accidents. Information messages like speed recommendation can be sent to improve fluency of traffic flow and reduce travel times. On the other hand the infrastructure can be supported with additional single vehicle data to improve decisions and actions.

Different standards are used for the exchange of information via short-range communications:

— for the forward channel, various ISO and ETSI standards using "C-ROADS C-ROADS Message Profiles" and
— for the return channel various ETSI standards using the CAR 2 CAR Communication Consortium Basic System Profile.

4.1.4.2 TM service provision with new cooperation models

The above described functional and technical extensions of the ITS value chain also open up completely new possibilities for cooperation between public road operators and public and private service providers in the sense of a Cooperative Traffic Management. This has led to a number of initiatives and projects dealing with the possibilities of the extended value chain with the aim of developing new cooperation and business models for collaboration between public road operators and private service providers.

TM2.0 - Traffic Management 2.0

Above all, the TM2.0 Innovation Platform initiative must be mentioned, which was launched in 2014 under the ERTICO umbrella of activities, bringing together 40 members from all ITS sectors to focus on new solutions for advanced interactive traffic management.

Since the foundation of TM 2.0, various task forces have worked out comprehensive concepts for various topics on how public road operators can cooperate with public service providers[29]

Cooperation models from SOCRATES$^{2.0}$[30]

SOCRATES$^{2.0}$ is a pan-European project that brings together road authorities, service providers and car manufacturers with the intention to set new standards to share and integrate traffic information. This shall enable effective traffic management and shall open the door to innovative traffic information and navigation services.

SOCRATES$^{2.0}$ has identified three key components of a future-oriented Traffic Management cooperation model[31]:

- **Degree of commonality**: To what extent is a common plan for coordinated action agreed, are all actors developing a common situation picture or a common view, or are the actors acting independently of each other?
- **Level of detail in the provision of information and strategy**: What is the level of detail in the provision of information? A distinction must be made here:
  - Situational: data from sensors, detectors, etc. (status/situation of transport networks and traffic flow).
  - Operational: Transmission of information on concrete actions and measures of traffic management.
  - "Tactical" information: Information on the motives of public traffic management ("motivation") to trigger certain strategies or actions at a given moment.
  - Strategy: Transport policy objectives, priorities and basic traffic management strategies. This also includes (political) targets (e.g. particulate matter alarm, CO_2 reduction, routing compatible with the city, etc.), which traffic management must take into account.
- **Degree of commitment between the actors involved**: Are the actors free to use or implement the information, plans or strategies, or have the actors agreed on the use, compliance and achievement of certain targets?

The model is depicted in Table 25.

29 http://tm20.org/final-reports-on-task-forces/
30 https://socrates2.org/
31 KOLLER-MATSCHKE, 2018; YPERMAN, 2018

Table 25: **SOCRATES$^{2.0}$ Cooperation matrix**

Degree of commonality	**Degree of commitment between the actors involved**		
	No common approach, pure information exchange	**common approach, shared perspective**	
	Cooperation agreement		
	No cooperative services	**No cooperative services**	**Cooperative services**
Situational	Traffic monitoring with own instruments / methods	Data exchange, cooperative development of a web service and optional own monitoring	Cooperative development of a web platform and agreement to use it
Operational	Individual identification and implementation of measures	Exchange about measures and optional improvement of own measures	Cooperative identification, selection and application of measures and actions
Tactical information	Individual definition and selection of the motives	Exchange about motives and motivations, improvement of own approaches	Cooperative determination, selection and application of motives and motivations
Strategy	Individual development and application of the target system	Exchange on objectives and priorities, and improvement / revision of objectives	Cooperative development and application of objectives and priorities

Based on the findings of the SOCRATES$^{2.0}$ pilot studies, SOCRATES$^{2.0}$ has developed three cooperation models (CM):

Figure 42: **SOCRATES Cooperation models**

Data exchange (CM A)

- Individual collection / measurement of data and provision of the same
- Mutual data provision on the basis of an agreed protocol (data format)
- *Example: Speed control, release of lanes*

Common View (CM B)

- Development / interpretation of a common view (traffic situation) based on shared data
- *Example: environmental zones, construction sites*

Coordinated actions (CM C)

- Development and introduction of cooperative services for travelers
- Coordination of the actions of all actors
- Cooperative development of KPIs and agreement on transport policy objectives
- *Example: „smart“ (=city-compatible) route selection*

The three cooperation models (CM A to C) build on each other:

— In the simplest model (CM A), traffic data and information are collected or measured individually by public and private actors and then made available to all actors. In line with the broad approach of SOCRATES$^{2.0}$, the data provision includes both public sector data (e.g. data from detectors) and data from routing services. How the other actors then handle the data or how they use it is up to each individual.

— CM B (common view) goes one step further, in which all actors agree on a common traffic situation picture on the basis of the jointly exchanged data. Nowadays, each actor (e.g. Traffic Control Centre A, Routing Service A, Routing Service B, MaaS Service C, regional association 1 ...)

creates its own traffic situation picture based on the data it collects. Since no actor has access to all data, the respective traffic situation pictures are "distorted" and do not reflect the entire traffic situation / mobility behaviour. By making all available data from all actors available, new opportunities would be created to generate a complete and ultimately common picture of the traffic situation in a region. The aim is to achieve a common understanding of the problems in the mobility sector.
— The third and most profound cooperation model is that of coordinated actions (CM C). Based on common data and a common situation picture, actions of all actors are coordinated, whereby here an action can be understood as an individual strategy recommendation or measure (e.g. changing permissible maximum speeds on a route section) as well as the joint development of KPIs or transport policy objectives.

All three cooperation models require a different, strongly developed mediating role:
— For the pure data exchange in CM A no intermediary is required.
— In CM B the intermediary could take on the role of a (neutral) traffic observer.
— In CM C the mediator additionally takes on the roles of strategy management, traffic manager and impact analysis.

LENA4ITS cooperation models

LENA4ITS is an already completed German project in which a model for the cooperation of public traffic management and private navigation service providers was developed. The project distinguishes between data and strategy cooperation; the latter is further subdivided into four different levels[32]:

Data cooperation
The aim of the data cooperation is to create an improved data basis for the assessment of the traffic situation for all players through mutual data exchange, thus contributing to an improvement in public strategies as well as individual route recommendations. This is based on the acknowledgement that currently no actor has a complete overview of the traffic situation because nobody has access to all available data. Only a mutual exchange of data enables a complete view.

The public authorities could obtain aggregated data from the routing services, in particular, based on FCD, while the routing services are particularly interested in public planning data and event data.

LENA4ITS proposes to organize the data exchange on the basis of bilateral agreements via National Access Point MDM.

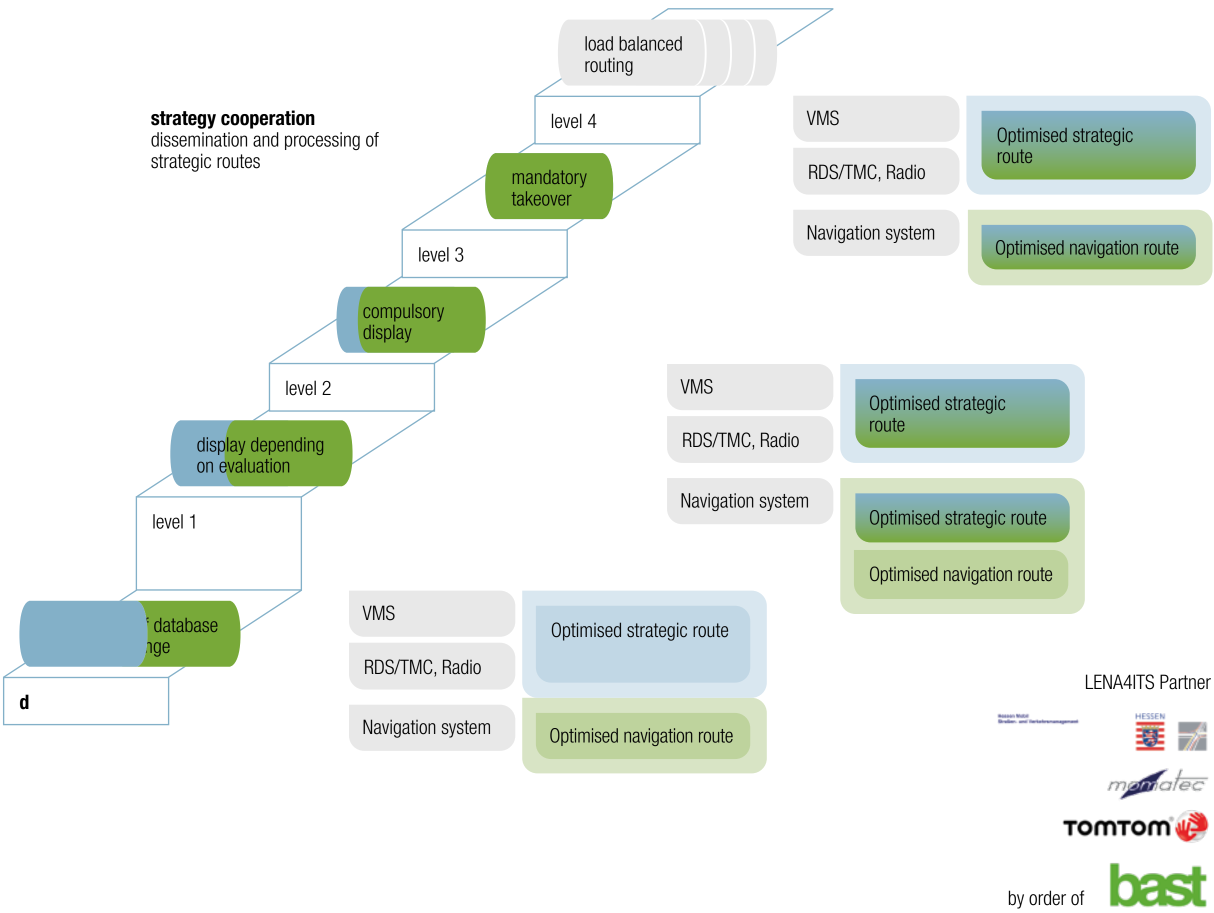
Strategy Cooperation
In the strategy cooperation, the public authorities and routing services cooperate with each other with the aim of harmonising suitable strategic recommendations. In particular, the aim is to integrate public strategy recommendations into individual routing; in addition, a bidirectional exchange of recommendations in the direction of cooperative traffic management is also conceivable in the future.

Within the framework of this cooperation, the public authorities provide coordinated dynamic strategy routes, while the routing services include them in the individual routing according to certain specifications on the basis of concrete agreements. The implementation of the strategy exchange is also to be carried out via the National Access Point MDM.

32 VON DER RUHREN, 2014, p. 39ff.

As shown in Figure 43 LENA4ITS distinguishes the following levels of strategy cooperation:

Figure 43: **LENA4ITS cooperation models**



— **Level 1 - Conditional display**: A public strategy route is made available to road users as an alternative route after positive evaluation by the routing service (in addition to the route recommendation of the routing service itself). If the evaluation is negative, the strategy route is not displayed. The road user can then choose which recommendation to follow. The evaluation by the Routing Service is based on three criteria:
  - Quality index: By a quality index provided by the public authorities,
  - Trust index: By means of a trust index determined by the routing service itself, which changes depending on the issuing authority (how reliable is the issuing authority?)
  - Case groups according to user settings.

— **Level 2 - Mandatory display**: The public strategy route must always be displayed by the routing services as an option next to their own route recommendation. Here too, the road user decides which route to use. A corresponding attribute (e.g. “binding”) must be set in the strategy message so that the routing service knows that this strategy recommendation is mandatory to be displayed.

— **Level 3 - Sovereign order**: Mandatory takeover of the public strategic route. Any route recommendations of the routing services are discarded. The road user cannot choose between different route recommendations.
— **Level 4 - Burden-sharing routing (future option):** Here, the public authorities and the routing services cooperate in such a way that, based on the current traffic situation, the traffic flows are distributed as best as possible over various route alternatives, taking into account their individual destinations and free remaining capacities. The public authorities pass on a strategy route to the routing services in the form of a proportionately dosed route recommendation, whereby the latter take the proportions into account by (random) allocation.

Both types of cooperation can be considered independently, but according to LENA4ITS, a strategic cooperation will enjoy lower risk, better results and higher mutual trust if it is flanked by data cooperation.

Overall, the cooperation models presented increase with each level the commitment and intensity of the cooperation between public authorities and routing services. In the absence of overriding legal or normative guidelines, LENA4ITS concludes, "… this presupposes a well-founded interest on both sides and a corresponding drafting of bilateral cooperation agreements".

4.2 TMS-01 Dynamic Lane Management

4.2.1 ITS Service at a glance

ITS service definition

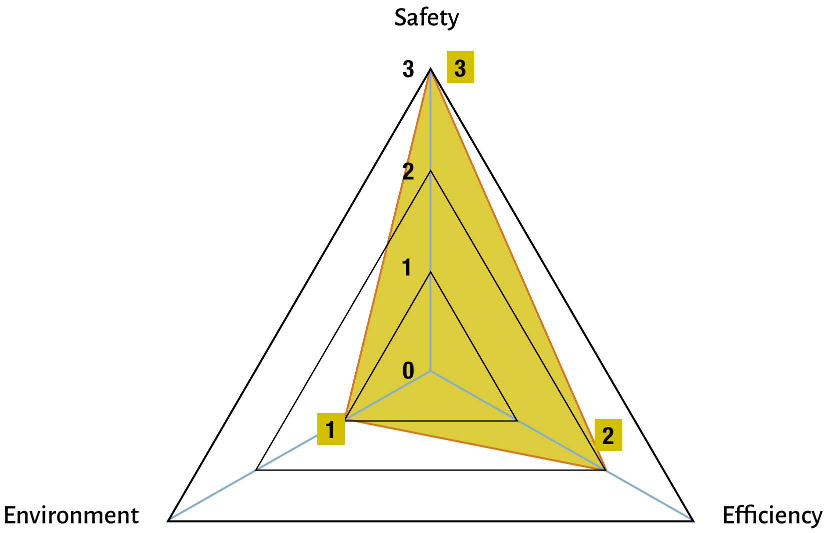
Dynamic lane management (DLM) service enables a temporally modifiable allocation of lanes by means of traffic guidance panels, permanent light signals, multiple-faced signs, LED road markers, closing and directing installations, etc.

Fundamental applications of this service are:
- tidal flow systems,
- lane allocation at intersections,
- lane allocation at tunnels,
- hard shoulder running,
- lane control in case of blockage/incident on the lane.
- Lane allocation can be also applied in special locations such as border stations, payment stations and ferry ports and these requirements are applicable to those applications.

ITS service objective

The overall objective of the dynamic lane management (DLM) service are:
- traffic actuated allocation of traffic flows, therefore higher capacity through better usage of the available cross-section.
- to achieve a temporary closing of lanes in case of accidents, incidents, maintenance work and construction measures (safeguarding of lanes).

ITS service radar



ITS service key words

Dynamic Lane Management, DLM, Tidal Flow, Lane allocation, Hard Shoulder Running, Lane clearance

4.2.2 ITS service profile

4.2.2.1 General ITS service description

Dynamic lane management (DLM) enables the number of lanes in one direction at a given point of the network to vary. Dynamic Lane Management techniques include the use of traffic guidance panels, permanent light signals, multiple-faced signs or prisms, lane lights, closing and directing installations and so on.

Dynamic lane management can be activated at fixed times or in particular conditions of heavy volumes of traffic, or in case of incidents, ad-hoc road work or other blockage on the specific lane, usually by means of variable message signs or other typologies of road signs.

To ensure that there are no blocks like broken-down vehicles or other objects on the lane or hard shoulder to be allocated, permanent video surveillance using Automatic Incident Detection is recommended, in particular for temporary activated systems (like reverse lane use).

4.2.2.2 What is the vision?

Use of the Dynamic lane management (DLM) is differentiated according to the following fundamental applications:

Tidal flow system

A tidal flow system is defined as the dynamic management of lanes for one direction on road sections. This allows operators to temporally (daytime, event-based) react to different capacity requirements in different directions of route sections. These sections are delimited by means of transition areas at the beginning and at the end of the section. In the case of tidal flow systems, suitable control measures have to ensure that the lanes are released in one direction only and that "driving in the wrong direction" is excluded. The reversible allocation of an additional lane to one direction during peak hours reduces the traffic density per lane at equal inflow of traffic and therefore traffic flow is improved while the frequency and extent of incidents are reduced at the same time.

Lane allocation at the intersection

Intersections can be involved in lane signalization as long as the cross-section and the directional allocation of the respective lanes are kept in the intersection area. An additional lane allocation on the approach to signal-controlled junctions increases the traffic capacity and reduces congestion at unchanged green periods.

The target of dynamic lane management at access points to motorways is the variable management of lanes on the main carriageway and the access ramp. On the main carriageway, the right lane is closed for through traffic while at the same time the lane is provided as an additional access lane of the ramp. Thus temporally increasing capacity demands of entering/exiting traffic with low loads on the main carriageway are taken into account.

Lane allocation before and in the tunnel

The possibilities and application areas for dynamic lane management at entry links to and inside tunnels should guarantee safe and smooth traffic use of the tunnels as far as possible, both in the normal case and in case of incidents, construction and maintenance works. With this aim the traffic is guided on to the counter flow lane, the so-called counter-flow operation, and guided together with the traffic in the contra-flow tube lane in case of closures in the tunnel or total closure of a tunnel tube.

Hard shoulder running

Temporary hard shoulder running provides a significant capacity increase of the crossroad section. In order to exploit the benefits of the higher capacity of hard shoulder usage, and to minimize the safety loss due to the removal of the hard shoulder, certain preconditions have to be fulfilled before the release (technical equipment, proof of economic efficiency, provision of emergency stops, infrastructure conditions).

Lane clearance ahead of road-works sites

Variable message signs (VMS) or dynamic prisms are used here to protect work teams on the roads/motorways. This use of VMS or dynamic prisms for dynamic lane management (DLM) helps to keep traffic flowing smoothly because drivers know what is happening some hundred metres ahead of the road works site and have enough time to change lane without the need to brake. Furthermore, this procedure represents an additional element of safety for road workers.

Lane clearance due to incidents

For this typology of dynamic lane management (DLM) existing VMS are used to guide traffic from the lane impacted to neighbouring lanes in advance of the incident location and thus to assist police on the road/motorway. Agreements should be concluded with Police, Traffic Officers or rescue staff (according to the system applied in each country) in order to activate VMS and to agree in advance the content of the messages on the VMS.

4.2.2.3 What is the mission?

The overall objectives of Dynamic Lane Management (DLM) services are:

- to optimize the capacity of existing roads by using dynamic devices that affect vehicle flow by assigning the number of lanes that are open or the types of vehicles which are authorized,
- to achieve a temporary clearance of lanes in case of accidents, incidents, maintenance work or construction measures (safeguarding of lanes),
- to allocate lanes on black spot areas (bridges or tunnels) or at locations with poor safety records.

In most cases, Dynamic Lane Management provides options for road managers with a temporary increase or decrease of road sections (working sites and incidents are exceptions to ensure the safety for road users). DLM is meant to be implemented on road sections or network areas concerned with highly varying traffic loads and capacity issues.

The tidal flow system is appropriate on sections without any kind of built lane separation. Otherwise, crossover sections have to be deployed according to the network geometry, e.g. before tunnel sections.

DLM is concerned with the misuse or unclear instructions given to road users through VMS or fixed signs. Therefore, road operators should be concerned with information display with the intent to inform users in the least ambiguous way (VMS, fixed signs or traffic lights). Road operators should also focus on safety precautions before activating the DLM services.

From a global perspective, DLM measures have the positive effect of limiting congestion in a specific spot.

According to the different implementations of DLM, specific objectives are:
— **Tidal flow system:** The objective of tidal flow systems is to react to capacity demands on route sections for different directions (real-time or scheduled events).
— **Lane allocation at exits:** The objective of DLM service at exits of motorways is to variably assign the lanes of the main carriageway and the access ramp in connection with traffic demands of the two sections.
— **Lane allocation before and in the tunnel**: The objective of dynamic lane management before and in tunnels is to ensure safe and smooth use of tunnels as far as possible for both normal conditions as well as in the case of incidents.
— **Hard shoulder running**: The objective of temporary hard shoulder running is to significantly improve the capacity of the road section. When it is done with variable speed limits, the overall safety situation should be improved.
— **Lane clearing ahead of working sites**: The objective is to use existing and/or mobile VMS to protect work teams on the road/motorway.
— **Lane clearing due to incidents**: The objective is to use VMS to assist police, road operators and rescue teams on the road/motorway.

Note: Hard shoulder running is a specific application case of dynamic lane management. A dedicated ITS Core service profile describes this application, consequently the present DLM service description doesn't present any information, requirements or recommendations dealing with this specific application. They are described in the Hard shoulder running service description (see TMS DG04).

4.2.2.4 Distinctiveness from other ITS services

Relevant information for this service is:
— Traffic conditions status on the network

Relevant complementary information, not included within this service profile and to be covered by other ITS Core services, is:
— Pre-trip and on-trip information services which may be used to inform users pre-trip or on-trip about the current operational status of the dynamic lane management service (see TTIS-01 and TTIS-02),
— Hard Shoulder Running is a special application case of dynamic lane management. A dedicated ITS Core service section describes this application (see TMS-04),
— Information provision should be coherent with Traffic Management Plans (TMP, see TMS-07) initiated by road authorities or traffic management centres, with Incident Management Information (TMS-06) and Overtaking Ban Information (TMS-05).

4.2.3 Harmonization requirements and advice

4.2.3.1 ITS service definition

"Dynamic lane management (DLM) service enables a temporally modifiable allocation of lanes by means of traffic guidance panels, permanent light signals, multiple-faced signs, LED road markers, closing and directing installations, etc.

Fundamental applications of this service are: tidal flow systems, lane allocation at intersections, lane allocation at tunnels, hard shoulder running."

Dynamic lane management (DLM) provides a way of optimizing the capacity of existing roads by using dynamic devices that affect vehicle flow by assigning the number of lanes that are open or the types of vehicles that are authorized.

The service is mainly applicable along the network characterised by:
— flow-related problems (daily or seasonal) and/or
— safety problems

The additional following main parameters are generally taken into consideration for the deployment of this service:
— the traffic flow
— the period
— the presence of particular critical events.

Dynamic lane management can be deployed on motorways, 3 or 4 lane roads, corridors, peri-urban motorways, critical spots. In most cases (if not in the standard case) DLM is a part of a traffic control system and needs to be coordinated with other systems (i.e. speed limit, incident warning, hard shoulder running, HGV overtaking ban).

4.2.3.2 Functional requirements and advice

4.2.3.2.1 Functional architecture

Figure 44 shows the interface architecture of the Dynamic Lane Management service.

Figure 44: **Interface architecture of the Dynamic Lane Management service**

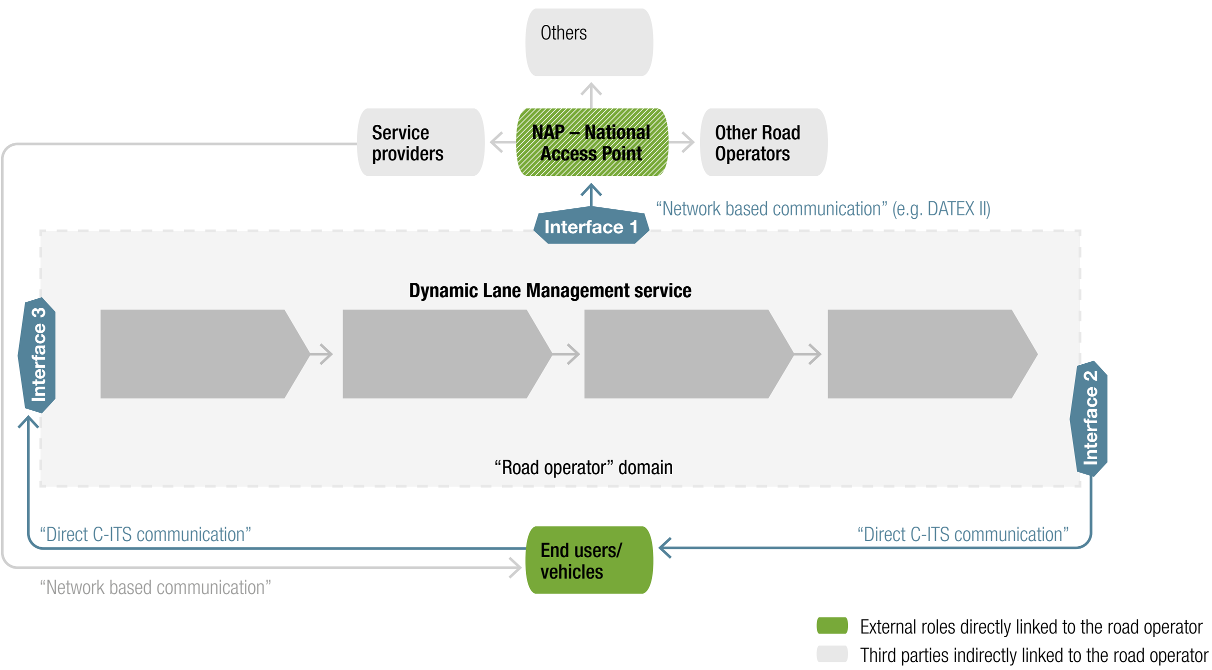
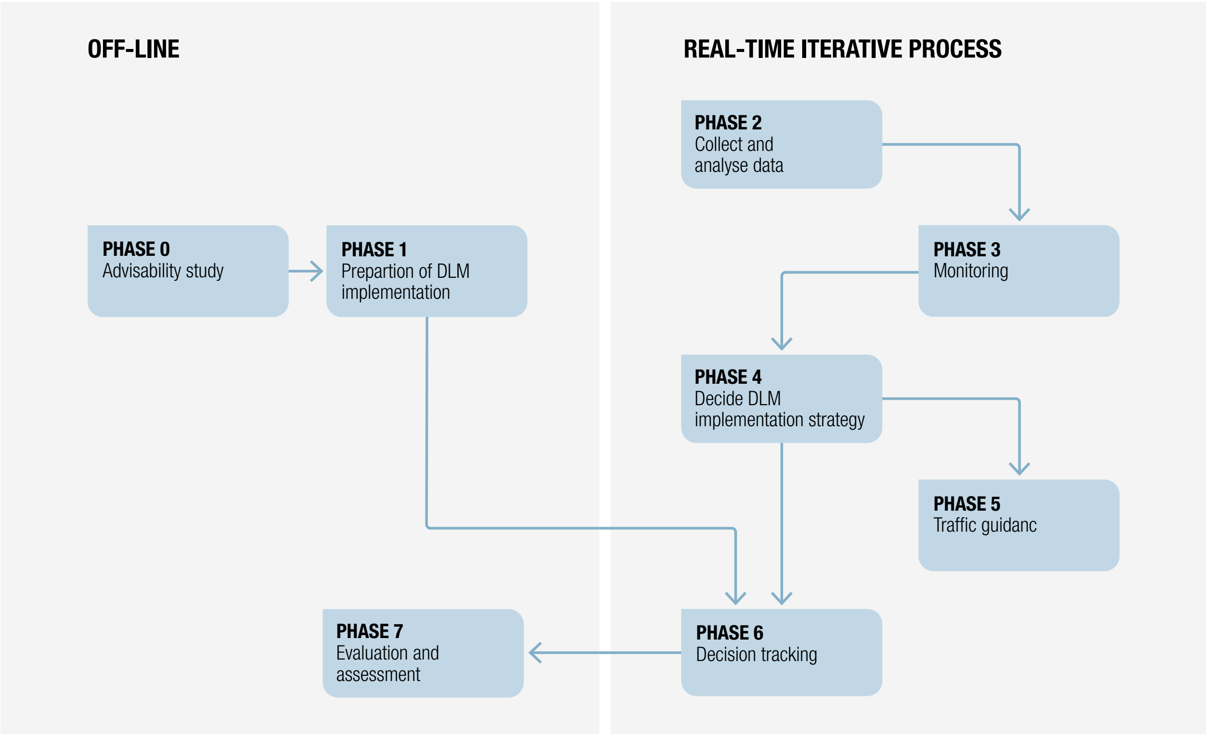


Figure 45 shows the typical functional and information architecture of the Dynamic Lane Management service.

Figure 45: **Iterative process of Dynamic Lane Management development**



<u>Functional requirement:</u>

— **FR1**: Dynamic lane management service implementation **should** be carried out the following functional decomposition into sub-functions:
  - Carry out an advisability study
  - Prepare the Dynamic lane management implementation
  - Collect and analyse data transmitted from monitoring systems
  - Monitoring
  - Decide the relevant Dynamic lane management implementation strategy to apply
  - Traffic guidance to road users
  - Track the decision for assessment use
  - Evaluate and assess, measure the impacts in order to provide recommendation and improvement (if possible)

4.2.3.2.2 Functional requirements and advice

Sub-function "Prepare implementation"

<u>Functional requirements:</u>

— **FR2**: An analysis of traffic flows and current and required infrastructure **may** be carried out before implementing the service to define whether it is needed or not, if it will bring benefits to traffic efficiency and if it is feasible

— **FR3**: Physical layout – the following items shall be taken into account:
  - acceleration and deceleration ramps **should** be long enough to let vehicles have the time to

check the carriageway before entering it, without causing queues
- enough lay-bys **should** be available to allow vehicles to stop in case of emergency when lanes are allocated (especially for hard shoulder running)

Sub-function "Data collection and analysis"

This sub-function includes traffic monitoring and road clearance control. The devices and methodologies for traffic data collection are not covered by this service description. They depend amongst others on the particular used data collection system and are left to the operator to select.

Functional requirements:

— **FR4:** Monitoring: infrastructure and control equipment **should** be used to monitor the traffic conditions and regulate traffic flows. Monitoring data collection system (also CCTV) **should** be able to detect real-time vehicle flow and speed.

— **FR5:** Road clearance monitoring: before applying any dynamic lane management (DLM), it **must** be verified that no car is stopped on the dynamic lane or in lay-bys from where no signs are visible (done by video-cameras and/or police or alternative technologies where appropriate).

— **FR6**: The clearing process **should** take place by controlling lane availability. This can be done for the whole section or in stages. To start the clearing process, particularly with lane safeguarding, a yellow/white lane divert arrow (with or without flashing lights) **should** be used as transition signal, before lane closure signs (red crosses) are used in advance of the incident site.

— **FR7**: Site investigation: local control devices **must** be connected to a traffic control centre. Operators in the traffic control centre **must** have access to an interface to remotely monitor traffic detectors and activate all VMS on the carriageway, managed by the centre itself using where applicable a decision support tool.

— **FR8:** Safety procedures: procedures **must** exist in order to apply all safety measures (before and during the DLM process). Safeguarding measures in the form of dynamic road markings, closing and guidance facilities can then be launched.

— **FR9**: Before the lane under control is 'released' for temporary use, it **must** be checked whether the lane concerned is available and safe to use for the corresponding traffic by means of video monitoring, police, traffic officers or alternative technologies as appropriate.

Sub-function "Traffic guidance to users"

Functional requirement:

— **FR10**: Traffic guidance to road users: when implementing a dynamic lane management (DLM) system, the road users **must** be informed about the availability of lanes by using suitable information means such as variable message signs, permanent light signs, multiple-faced signs or prisms or lane lights.

4.2.3.3 Interface requirements

Interface requirements:

— **IFR1**: If the Dynamic Lane Management service provides dynamic lane information at interface 1 (see Figure 44) it **must** provide coded information including the following elements:

— Type of the dynamic lane management, and, if applicable, the type of constriction

— Location of dynamic lane management, if applicable including additional information on effected or restricted lanes and the residual number of lanes

— If applicable start time and end time of the dynamic lane management

— **IFR2:** If interface 2 is implemented, the Dynamic Lane Management service must provide at interface 2 (seeFigure 44) Dynamic Lane Management information coded in C-ITS messages including the following elements:

- the respective road signs for dynamic lane management
- respective road signs relevant for the situation

— **IFR3:** When relevant, the Dynamic Lane Management service **should** collect at interface 3 (see Figure 44) C-ITS coded Probe Vehicle Data information (microscopic traffic situation) relevant to this ITS Core service.

4.2.3.4 Organisational Requirements

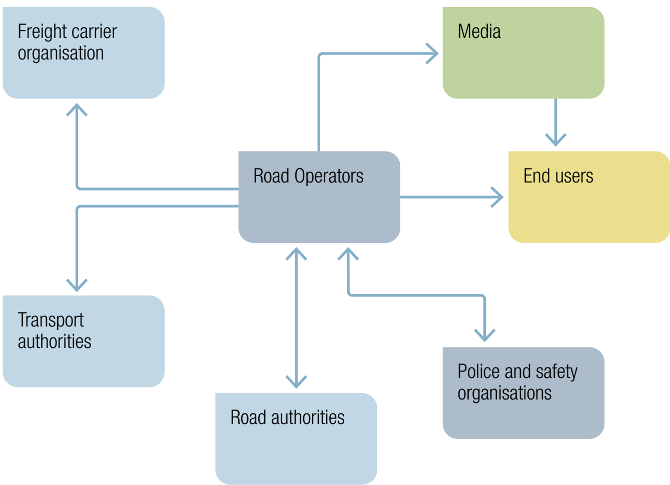
The implementation of Dynamic Lane Management comprises different applications:
— Tidal flow system
— Lane allocation at junctions
— Lane allocation before and in tunnels
— Hard shoulder running
— Lane clearing ahead of working sites
— Lane clearing due to incidents.

Independently of the initial objectives, the expected benefits of the service mainly rely on the implementers' involvement and the end users' acceptance.

DLM usually involves a range of partners such as road authorities, road operators, the police, the fire brigade, ambulance services, recovery services and the media. Performance of the DLM process relies on an overall cooperation. This cooperation should be initiated some time before the operation of the DLM service to ensure service continuity and quality display of the DLM service.

Organisational Architecture

Figure 46: **Organisational architecture**



Organisational requirements:
— **OR1:** The organisational and operational structure of the service, as well as the role of each organisation/body and its tasks, **must** be defined.
— **OR2:** Appropriate procedures **must** be defined for the activation and deactivation of the dynamic management of lanes.

4.2.3.5 Common Look & Feel requirements

The dynamic management of lanes is displayed to users by means of Variable Message Signs. When dealing with cross-border or cross-regional dynamic lane management (DLM) systems, Variable Message Signs display should be as harmonised as possible so as to be more comprehensible to users. The display is usually located overhead (VMS mounted on traffic sign gantries) or laterally in single cases (VMS mounted on masts) besides the carriageway.

The compliance rate and the acceptance of systems with dynamic lane management (DLM) by the car drivers may vary heavily dependent on the comprehensibility of the operated switching. It should therefore be checked and improved, if needed, by a comprehensive quality control.

End-user acceptance of the system can be improved by deploying Variable Message Signs which provide users with detailed information of how to behave on the section affected by dynamic lane management (DLM). Such information, given to the users progressively, can make them feel safer: in the case of hard shoulder allocation, for instance, users should be informed in advanced that the system is active, how they can profit from an added lane opened (or in the case of HGV how they are obliged to keep to the inside lane), how they have to reduce speed, how long an additional lane is sustained and when the system reduces lane availability again. The more the system is comprehensible for users, the more they accept it.

All measures can then be considered to be successful when users easily understand them and traffic flow is kept under control.

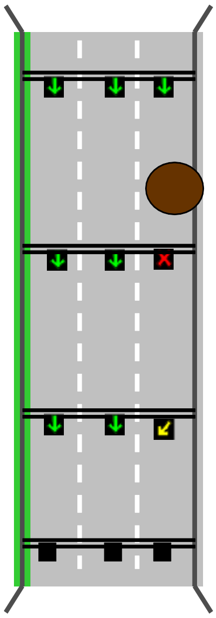
General requirements

In the process of harmonisation, Dynamic Lane Management is part of a traffic control system and the requirements listed below are some general requirements to be fulfilled when Dynamic Lane Management is activated. It has to be considered that DLM deals with a lot of different situations and in some cases exceptions must be possible.

Common Look & Feel requirements:

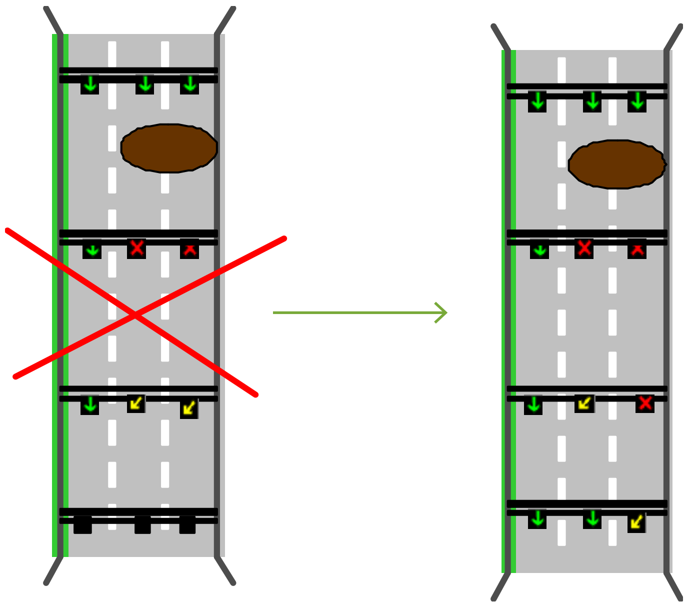
- **CL&FR1:** The display of signs/pictograms on VMS or other end-user devices **should** be in accordance with prevailing national road codes and:
  - Member States which ratified the Vienna Convention MUST respect the Vienna Convention and the European agreement supplementing the convention (1st May 1971) and SHOULD consider the Consolidated Resolution on Road Signs and Signals (R.E.2).
  - Member States which did not ratify the Vienna Convention SHOULD follow the Vienna Convention and also consider the R.E.2.
- It is up to the deploying road operator to ensure that real signs are legally compliant and widely understood by the road users.
- **CL&FR2**: Normally every VMS **must** display a sign (green arrow, yellow/white deflection arrow, "end of restriction", red cross or speed limit) over each lane when VMS is in active use. An exception to this is the use of red crosses over "hard shoulder running lanes" or special "rush hour lanes" that are not in use; in those cases there is no need to display any sign on VMS.
- **CL&FR3**: A yellow/white deflection arrow **must** be displayed before the closure of the lane (red cross) when it was opened before.

Figure 47: **DLM signage for instance in case of accident**



- **CL&FR4**: A yellow/white deflection arrow **must not** point towards a lane that appears closed on the next signal gantry.
- **CL&FR5**: The road operator **must** close only one lane at a time, if DLM arrangement enables the operation.

Figure 48: **DLM signage in case of accident**



- **CL&FR6**: At the end of the DLM zone, normal allocation of lanes **must** be indicated on VMS display either by a green arrow or by an "end of restriction" sign or maximum allowed "speed limit sign".
- **CL&FR7**: When there is a wish to display both a speed limit and a green arrow over the lanes, an additional VMS **should** be used.

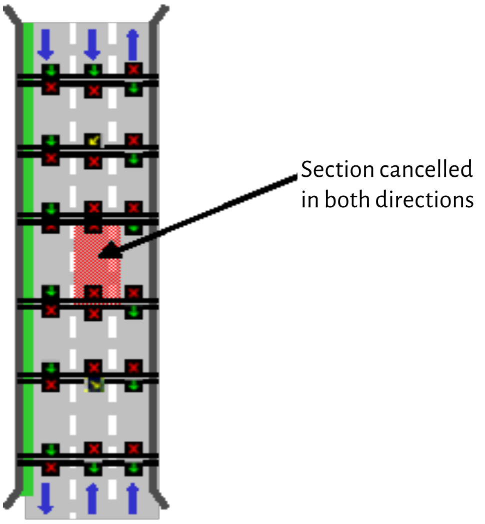
— **CL&FR8**: The distance between 2 VMS series **should** not be too long (suggestion: < 1000m).

Tidal flow system requirements

Common look & feel requirement:

— **CL&FR9:** On the dedicated tidal lane at least one section of the lane **must** be cancelled to traffic prior to DLM implementation: one on both directions.

Figure 49: **Tidal flow system**

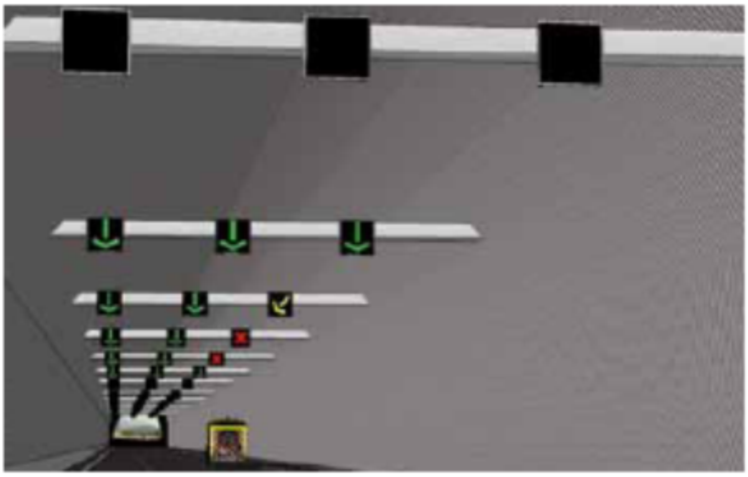


Lane allocation before and in the tunnel

Common look & feel requirements:

— **CL&FR10**: VMS series **must** be installed so as to ensure maximum service visibility.

Figure 50: **DLM in a tunnel**



— **CL&FR11**: If lane availability within tunnels is reduced due to planned works or incidents, DLM **should** be activated before the tunnel entrance.

— **CL&FR12**: Lane allocation **should** remain constant within the tunnel as long as possible.

Lane clearing ahead of working sites

Common look & feel requirement:

— **CL&FR13**: DLM service **must** be activated in accordance with the local signalisation pattern

4.2.3.6 ICT Infrastructure requirements

The deployment of the dynamic lane management (DLM) requires a minimum infrastructure.

Technical requirements:

— **TR1:** Variable message signs or other typologies of road signs **must** be installed for the closure or release of lanes.

— **TR2:** Vehicle detectors **must** be installed along the main carriageway, providing information on current traffic conditions; in some cases, they are needed to decide whether to activate the DLM process

— **TR3**: Video surveillance (including CCTV) **must** be implemented for tidal flow, DLM in tunnels and for hard shoulder release.

— **TR4:** A control centre with competent operational software, visualization systems, reporting and report/system archiving systems **must** be available.

— **TR5:** All ICT Infrastructure described at technical requirements TR1 TR2 TR3 TR4 **should** be supplied with an uninterruptible power supply or/and an emergency power system to ensure the continuity of service in case the mains electricity power source fails.

4.2.3.7 Required standards and specifications

Variable message sign standards:

The most relevant standards in Europe concerning technologies and systems examined by this guideline are EN 12966-1/2/3:2005. Road vertical signs - Variable message traffic signs. These include:

— 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

Information provision standards:

— **IPS1**: If the Dynamic Lane Management service provides dynamic lane information at interface 1 (see IFR1), it **must** be profiled based on EN 16157-3:2019 using the DATEX II Recommended Service Profile for Dynamic Lane Management.

— **IPS2**: If interface 2 is implemented, Dynamic Lane Management information (see IFR2) **must** be profiled in an IVIM (Infrastructure to Vehicle Information Message) based on ISO 19321 using the C-ROADS C-ITS Message Profiles for the In-Vehicle Signage service, specifically the Traffic Sign Use-Case.

— IPS3: When relevant, the Probe Vehicle Data (microscopic traffic situation) information (see IFR3) **should** be collected, which is profiled based on ETSI EN 302 637-2 using the CAR2CAR Communication Consortium Basic System Profile.

4.2.3.8 Level of Service Definition

4.2.3.8.1 Level of Service Criteria

Table 26 gives the Level of Service recommendations for a Dynamic Lane Management service. The background of this concept is descripted in chapter 2.6.

Table 26: **Level of Service recommendations for Dynamic Lane Management**

Levels of Service criteria table: Dynamic Lane Management			
Core Criteria	**A**	**B**	**C**
Display of traffic information (support)	Dynamic information on lane allocation (arrows on VMS)	Dynamic information on lane allocation + possibility of speed limit	Dynamic information on lane allocation + possibility of speed limit + extra information (overtaking ban, etc.)
Monitoring	Manual via traffic officers and/or police	Semi-automatic via traffic officers and/or police cameras	Automatic via cameras, loops, sensors
Safeguarding	Physical	Physical and through cameras	Physical + cameras + automatic detection
Activation and deactivation	Manual	Manual and remote-controlled	Manual and based on decision support systems
Operational availability	Service periodically ensured during critical periods	Extended availability, when required	Service 24/7 ensured, when needed (in case of major events)

Note: Attention must be paid to Level C of "Display of traffic information (support)" because it could create information overflow if not well organised.

Each level shows a technical advancement, but a higher level is not necessarily better than a lower level.

4.2.3.8.2 Level of Service Criteria related to Operating Environment

Level of service requirement:

— **LoSR1**: In the case that pre-deployment surveys/evaluations provide the necessary evidence to proceed with the deployment of the ITS-service "Dynamic Lane Management", the minimum and optimum LoS **should** respect the following Level of Service to Operating Environment mapping table.

Table 27: **Levels of Service related to Operating Environments (see also chapter 2.5.3 and ANNEX C)**

DYNAMIC LANE MANAGEMENT			Operating Environment													
Criteria for the Level of Service			C1	T1	T2	T3	T4	R1	R2	R3	R4	S1	S2	N1	N2	P1
Display of traffic information (support)	C	Information about the dynamic allocation of lanes and users' guidance (arrows on VMS) with possibility of speed limits and other	O			O	O					O	O			
	B	Information about the dynamic allocation of lanes and users' guidance (arrows on VMS) with possibility of speed limits								O	O			O	O	O
	A	Just information about the dynamic allocation of lanes and users' guidance (arrows on VMS)	M			M	M			M	M	M	M	M	M	M
	/	*Service unavailable*		NA	NA			NA	NA	NA*	NA*					
Monitoring	C	Automatic via cameras, loops, sensors	O									O	O			O
	B	Semi-automatic via traffic officers and/or police and cameras				O	O			O	O			O	O	
	A	Manual via traffic officers and/or police	M			M	M			M	M	M	M	M	M	M
	/	*Service unavailable*		NA	NA			NA	NA	NA*	NA*					
Safeguarding	C	Physical + cameras + automatic detection										O	O			
	B	Physical and through cameras	O			O	O			O	O			O	O	O
	A	Physical	M			M	M			M	M	M	M	M	M	M
	/	*Service unavailable*		NA	NA			NA	NA	NA*	NA*					
Activation and deactivation	C	Manual and based on decision support systems	O			O	O					O	O			
	B	Manual and remote-controlled	M			M	M			O	O	M	M	OM	OM	OM
	A	Manual on-site								M	M					
	/	*Service unavailable*		NA	NA			NA	NA	NA*	NA*					
Operational availability	C	Service 24/7 ensured, when needed (in case of major events)	O													
	B	Extended availability, when required				O	O	O			O	O	O	O	O	O
	A	Service periodically ensured during critical periods	M			M	M	M			M	M	M	M	M	M
	/	*Service unavailable*		NA	NA			NA	NA	NA*	NA*					

Recommendatons for LoS per OE:

M	Minimum LoS recommended	O	Optimum LoS recommended
OM	Minimum = Optimum	NA	Not relevant
		NA*	Not relevant for two-lane roads

4.3 TMS-02 Variable Speed Limits

4.3.1 ITS service at a glance

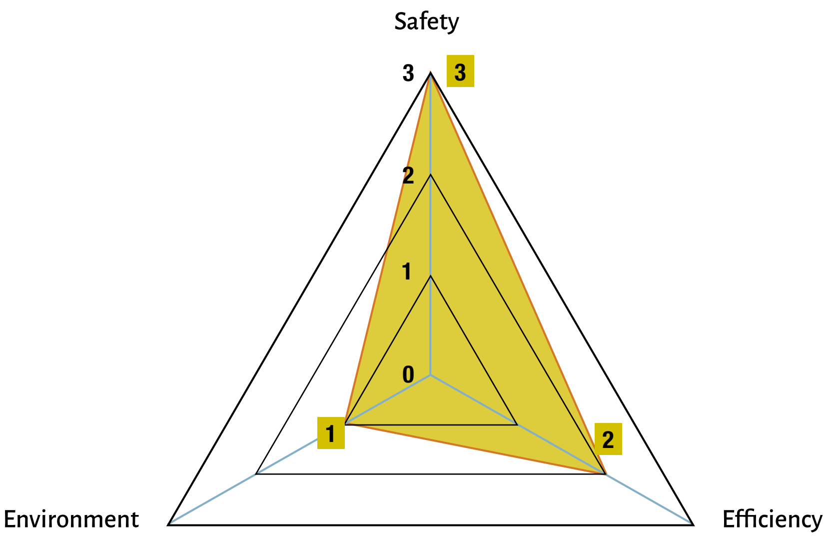
ITS service definition

Variable speed limit (VSL) system use Variable Message Signs (VMS) to display speed limits (maximum), advisory speed (recommended) or compulsory minimum speed, to guide drivers to travel at a speed suitable to the prevailing traffic, road or weather conditions.

ITS service objective

The common main objective of VSL is to support drivers travelling at a safe speed or to improve traffic fluency. In some cases, these systems are also used to mitigate environmental effects, such as pollution or noise.
In most cases, the displayed speed limit should correspond to the traffic, road and weather conditions the drivers encounter, and therefore will be experienced as relevant. The drivers are then more likely to adhere to the speed limits. This will result in better safety, better mobility, smoother traffic, increased comfort and a reduced impact on the environment. However, there are cases when circumstances call for a reduced speed limit for which the reason is not obvious to the drivers, i.e. environmental reasons or problems downstream like incidents or work zones.

ITS service radar



ITS service key words

Variable Speed limit, speed limit, speed harmonization
Traffic flow efficiency, Uninterrupted traffic flow, improved traffic flow, Traffic capacity
Traffic safety, Traffic calming, Traffic Restriction
Environment, Noise reduction, Emission reduction
Traffic management, Traffic control, Road and weather control, Traffic control centre, Control algorithm, Automatic control
Variable speed limit sign, fixed sign

4.3.2 ITS service profile

4.3.2.1 General ITS service description

Variable speed limit (VSL) system use Variable Message Signs (VMS) to display speed limits (maximum), advisory speed (recommended) or compulsory minimum speed for road users on specific road sections.

Speed limits are adapted to the particular weather, road and/or traffic conditions. Background system use gathered information and take decisions according the pre-defined rules and control signs on the road using telecommunication connections.

On motorways, VSL is mostly used to harmonise traffic flow and thus increase capacity and traffic safety. Weather controlled VSL has the aim to help drivers travelling at a safe speed according to the prevailing weather and road surface conditions. Environmentally controlled VSL systems operate in a similar way as weather-controlled systems, but with different detectors and control models. VSL can also be used at intersections to improve safety when conflicting traffic occur. The speed reduction has a safety effect in itself, but drivers are also alerted by the system, and are therefore more observant when driving through the intersection.

The basis for most variable speed limit systems is the detection of the current traffic conditions as well as the weather and road conditions through suitable sensors. Data from sensors are collected by local control systems and analysed in a control algorithm to make decisions according the pre-defined rules. The local control systems are mainly automatic but supervised by a Traffic Control Centre (TCC) or Traffic Management Centre (TMC).

VSL solutions have been implemented and tested in more or less all European countries. The implementations vary from small tests to broader large scale implementations. The purpose of using VSL is different from case to case. The general overall purpose is for safety reasons, to decrease speed and accidents, to harmonize the traffic flow for increased throughput and to adapt to the weather and road conditions. VSL is mainly used on motorways but also on other roads like trunk roads.

In some cases, VSL is supported by Speed Enforcement (SE), which mostly uses cameras to identify speeding vehicles and/or drivers. SE covers violations of speed limits either on a spot or over a defined section of the road, also called section control. Depending on the strategy, mobile and/or stationary speed enforcement is used. When combining VSL and SE it is especially important to display relevant speed limits and communicate the reasons for reduced speeds in order to maintain the confidence of the public. It is also paramount that the VSL and SE systems co-operate in a reliable way, so that the enforced speed limits correspond to the speed limits displayed by the VSL systems.

4.3.2.2 What is the vision?

The main purpose of VSL is to help drivers to travel at an appropriate speed considering the prevailing traffic, road or weather conditions. Sensitive road segments, like tunnels, are often subject to VSL deployment for safety reasons. VSL can also be used to mitigate negative effects for society in general, like pollution or noise and to increase traffic throughput.

4.3.2.3 What is the mission?

Regulating the speed limits so that the objectives of the specific deployments are met.

— Harmonisation of traffic flow to improve safety
  → Harmonization algorithms determine the optimal speed depending on the traffic volume on the main carriageway to avoid flow breakdowns and to increase throughput.
  Speed control dependent on rain, slippery roads or visibility
  → In the case of heavy rain, limited visibility or slippery roads due to ice and snow, it is recommended to adjust the speed limits to the surface conditions and/or stopping sight distance.
— Environmental criteria
  → Speed control can be used to mitigate the negative environmental effects of traffic, like pollution or noise, which has been proved in evaluations. Reduction of the allowed speed and smoother traffic flow can help to achieve the directive on air quality in populated areas.
  → User acceptance is a key factor to achieve the desired results. If the drivers understand the reasons for the displayed speed limits and experience them as relevant, they are more motivated to observe them.
— Other applications
  → VSL can also be used for example at bus stops, bridges subject to strong winds, tunnels, intersections and in order to help protecting vulnerable road users.
  → The service can also increase traffic safety by alerting and slowing down traffic approaching road works and unexpected incidents.

4.3.2.4 Distinctiveness from other ITS services

In practice, VSL is often an integrated part of a larger traffic management system, especially on motorways. These systems are often referred to as 'Motorway Control Systems', MCS.

Relevant complementary information, which is not the content of the VSL service and will be covered by other chapters are:
— Hard shoulder running, where VSL is an important ingredient (TMS-04).
— Dynamic lane management, where lane signals and VSL often share hardware (TMS-01).
— VSL may be combined with other variable road signs, like warning signs (for example fog, road works or queue, TMS-06) or prohibitory traffic signs (i.e. HGV overtaking ban TMS-05) with potential variable text signs.
— Ramp metering systems may co-operate with VSL (TMS-03).
— Speed Limit Information: Speed Limit Information services are implemented to keep the driver regularly informed of the regulatory speed limit. This can be achieved using roadside signing and in-vehicle systems which is described in TTIS-04 Speed Limit Information.

4.3.3 Harmonization Requirements and advice

4.3.3.1 ITS service definition

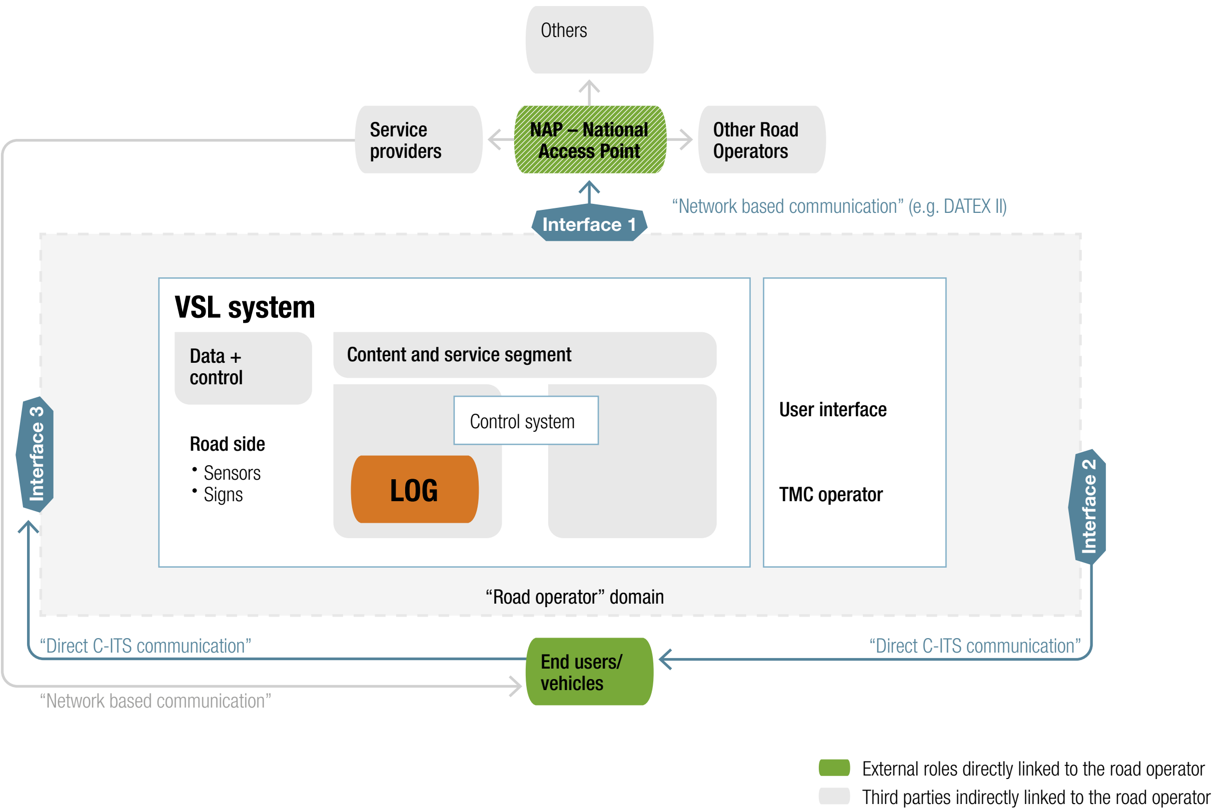
VSL system consists of variable speed limit signs, maximum, minimum or advisory, to guide drivers to travel at a speed suitable to the prevailing traffic or weather conditions, in some cases supported by Speed Enforcement, which mostly uses cameras to identify speeding vehicles and/or drivers.

4.3.3.2 Functional requirements and advice

4.3.3.2.1 Functional architecture

Figure 51 shows the typical functional architecture of a VSL system. Red arrows show possible interfaces to other services.

Figure 51: **Functional architecture “Variable Speed Limits”**



4.3.3.2.2 Functional requirements and advice

Functional requirements

— **FR1**: Functional decomposition and the provision of standardised interfaces **should** be carried out to ensure interoperability in cases where the service is carried out by more than one organisation (and is in any case recommended to be prepared for an easy functional decomposition, as could be the case in the future). Control and algorithms may be done through local (roadside) or central systems.

— **FR2**: Traffic Management Centre Operators **should** be trained in supervising the system, be able to control the system manually and override automatic operation. Exception: Local VSL systems sometimes can operate independently and need no supervision regarding current signposted speed limits.
— **FR3**: The central control system **should** have the ability to supervise and control each individual system. Exception: Local VSL systems sometimes can operate independently and need no supervision regarding current signposted speed limits.
— **FR4**: The signs **must** display the speed limit that the control system has requested, and functionality **must** be monitored continuously.
— **FR5**: To avoid unanticipated deceleration, gradual speed reductions **should** be shown as 20-40 km/h increments, dependent on operating environments, context, speed and road topology (note: 20 km/h reduction between two gantries is common practice on motorways).
— **FR6**: VSL systems **should** have a log that stores data about signposted speed limits, error messages, etc.
— **FR7**: Signs **should** report to the control system if message activation was successful or not and possible error messages.
— **FR8**: Automatic and semi-automatic systems **should** contain models and algorithms that calculate the speed limit and transmit it to the signs. These models and algorithms can be implemented in a central control system or at the roadside.
— **FR9**: Collected data **must** be of sufficient quality to provide adequate input in the control system, in some cases this can necessitate the installation of additional roadway sensors. Exceptions: For systems using clock and/or calendar control, sensors are replaced by the system clock. For manually controlled systems at road works, sensors are usually replaced by a keypad (local control unit) or similar.
Note: Systems may include both manual and automatic functions as well as several types of sensors. This requires well defined hierarchical rules and priorities.
— **FR10**: Detector data updating frequency **should** be adapted to the required response times. For instance, a normal updating frequency for traffic data is from real-time to one minute.
— **FR11**: The systems **should** have predefined handling of situations like power failure, disruptions in communications and other functional problems to avoid functional inconsistencies in the service. System parameters and error states **should** be disseminated in real-time to on-duty staff.
— **FR12**: If VSL systems interact with other services like hard shoulder running, dynamic lane management or HGV overtaking ban (or adjacent VSL systems), interfaces **should** be implemented either at roadsides or in central control systems. In practice, this can often be internal interfaces in the same system.

Functional advice:
— A general rule to achieve a good understanding and observance of VSL is that the speed limits have to be relevant for road users. Not only to achieve the individual but especially the collective relevance. This sets the requirements for data collection and control principles. It is relatively easy for the driver to understand that the speed limit is reduced when there is congestion or bad weather, but it is more difficult to communicate speed reductions due to, for example, environmental reasons. Therefore, road authorities can consider including a warning sign with a pictogram or a text showing the reason for the displayed speed limit.
— Automatic control shall be used whenever possible. You may also consider the option of using a semi-automatic mode where you set the maximum speed limit manually but let the system vary the displayed speed limit up to this threshold. This can be especially useful for long road works.
— When a VSL system is used to decrease the risk of rear-end collisions due to congestion, detector spacing shall be adequate to the function. The distance between detector and gantry needs to be adjusted.

- The control algorithms shall result in speed limits that are relevant to achieve the desired effects and responds quickly enough in critical situations
- The algorithms shall be constructed in an appropriate and stable way to avoid unnecessary switching of the speed limits.

The components in roadside equipment have to be of the correct environmental class to cope with the environmental conditions. For maintenance reasons, it is an advantage if the components of the systems are easy to reach and replace.

- When VSL is supplemented by speed enforcement, the monitoring technology used by private as well as public road operators, which generates evidence of speeding, has to meet the national legal requirements.

4.3.3.3 Interface requirements

Note: Interfaces are identified in general architecture (see Figure 51). DATEX II Recommended Service Profile is valid only for variable speed limit signs (maximum speed limit),

Interface requirements:

- **IFR1**: The Variable Speed Limit service **must** provide at interface 1 (see Figure 51) information on the current speed limit defined in DATEX II Recommended Service Profile including the mandatory data of following classes:
  - Common information
  - Location Referencing information
  - Road Traffic Data
  - Situation information
  - VMS, includes VMS panel information
- **IFR2:** If interface 2 is implemented the Variable Speed Limit Service **must** provide at interface 2 (see Figure 51) C-ITS coded information relevant to this ITS Core service.
- **IFR3**: When relevant, the Variable Speed Limit service **should** collect at interface 3 (see Figure 51) C-ITS coded information on Probe Vehicle Data (microscopic traffic situation) relevant to this ITS Core service.

4.3.3.4 Organisational Requirements

Organisational advice:

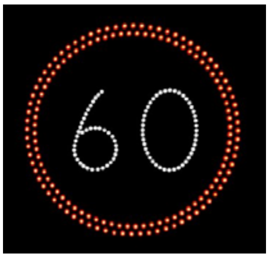
- The responsible organisation has to establish a good cooperation with the police and good communication with the public for the reasons and benefits of VSL. This is a key to success and encourages a positive attitude from drivers.
- VSL is mostly a concern of the Road operators (road authorities and motorway companies and its subsidiaries). However, these stakeholders can also be considered:
  - Municipalities and cities: At boundaries between state and municipal roads or when these systems influence traffic flow on municipal roads. Municipalities and cities may also implement VSL on their own networks.
  - Public transport authorities and operators: When these systems influence accessibility and schedules for public transport. It is also possible to consider priority for public transport in separate lanes in conjunction with VSL.
  - The Police: To enforce the speed limits for better compliance by road users. The police are generally an important partner when speed limits are enforced using automatic speed enforcement systems. Depending on national regulations, the police may also need to accept VSL projects formally.

— A cost-benefit analysis, as well as an analysis of the achieved effects in relation to the objectives, can be carried out when new VSL systems are deployed, unless similar projects already have been thoroughly evaluated.

4.3.3.5 Common Look & Feel requirements

— **CL&FR1**: Speed limits (maximum) **should** be displayed in one of the following ways:
- Discontinuous signs (**character matrix**): White, off-white or yellow figures on a black background enclosed by a red ring. Discontinuous VMS can also be used without colour inversion if national regulations allow or require this..
- Continuous signs (**full matrix**): Sign surface similar to fixed mandatory speed signs according to national regulations.

Figure 52: **Example of a VSL sign**



— **CL&FR2**: Advisory speed (recommended) signs **should** be displayed in one of the following ways:
- Discontinuous signs (**character matrix**): White, off-white or yellow figures on a black background. The sign can have a white rectangular border, but no red or white ring. Discontinuous VMS can also be used without colour inversion if national regulations allow or require this.
- Continuous signs (**full matrix**): Sign surface similar to fixed advisory speed signs according to national regulations

Figure 53: **Example of an advisory VSL sign**

— **CL&FR3**: Compulsory minimum speed **should** be displayed as a continuous sign (full matrix): Sign surface similar to static minimum speed signs according to national regulations.

— **CL&FR4**: To avoid driver confusion about which speed limit is valid, static and variable speed limit signs **should** never be mixed along a particular roadway segment. Variable and static speed limit signs must not be located on the same cross-section.

— **CL&FR5**: It **should** be obvious to the drivers when a section with VSL ends and what the valid speed limit is after that. Normally this is done using fixed speed limit signs.

— **CL&FR6**: For certain roadway segments speed limit signs **may** be active only when a reduced speed limit is set. In other cases, they **may** be blank. In some circumstances this makes it easier for the drivers to notice conditions that require a lower speed.
— **CL&FR7:** Signs **should** be located either above the carriageway or on the verge of the road. If signs are located on the verge, they **should** be signs on the near side of the road with possible supplementary signs to the offside. If there is more than one lane in the direction of travel, it is recommended to have signs on both sides.
— **CL&FR8**: If signs are mounted above the carriageway, each lane **may** have one speed limit sign located above (indicating speed limit of that lane only) or a single speed limit sign integrated in a larger VMS, applicable to all lanes.

Figure 54: **Portal mounted VSL signs on motorway, one sign above each lane according to CL&FR5**

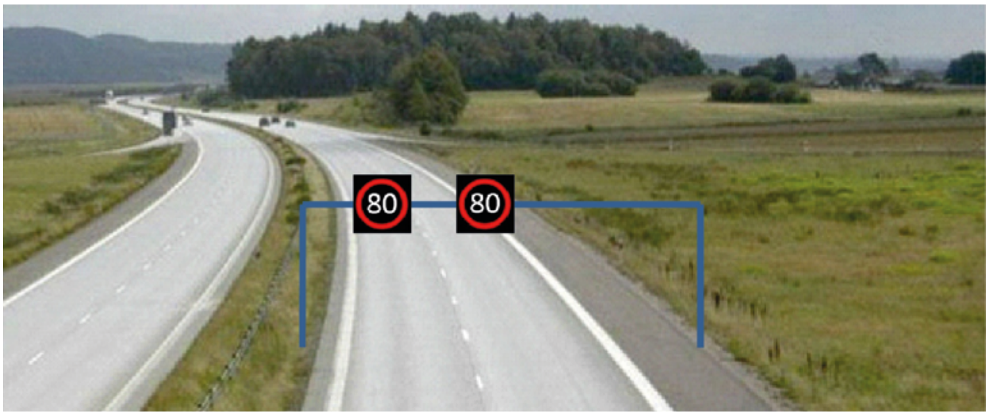


Figure 55: **Portal mounted VSL signs on motorway, one speed limit sign integrated in VMS according to CL&FR5**

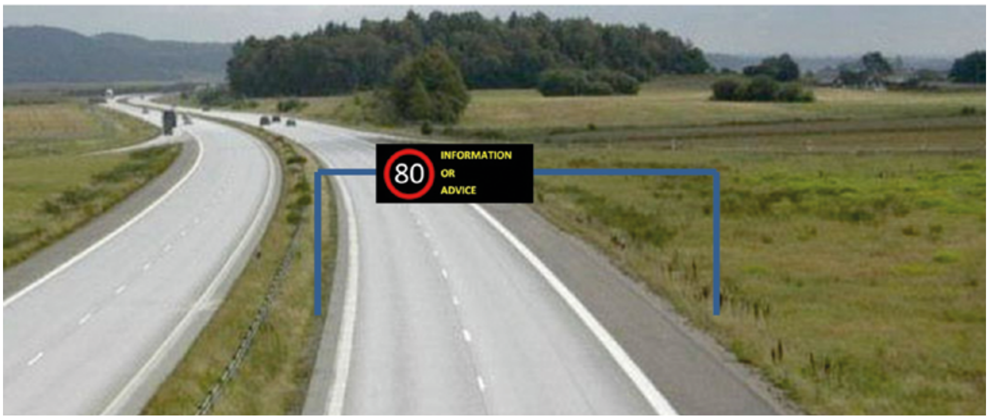
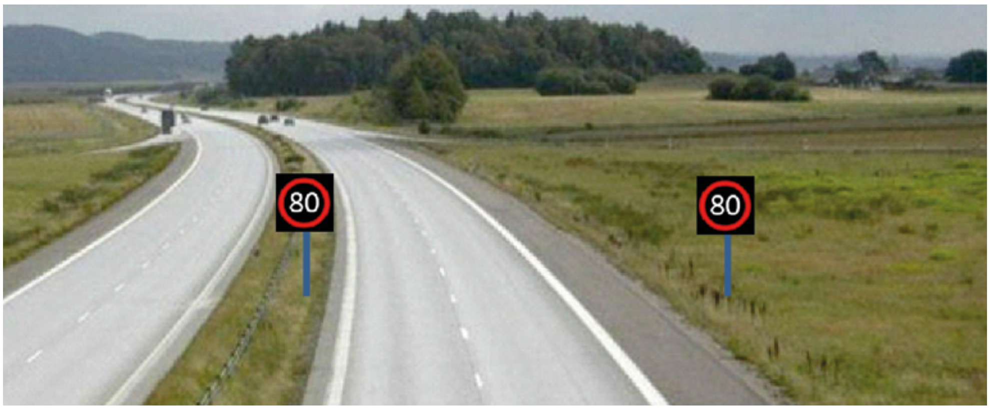
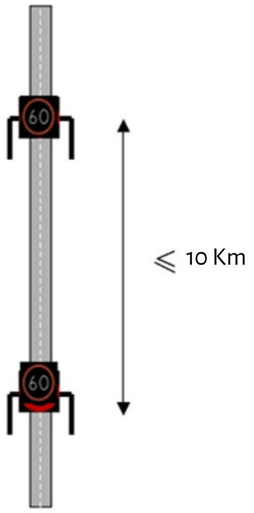


Figure 56: **Side mounted VSL signs on motorway**



— **CL&FR9**: Speed limits **should** be repeated at least after every entry slip road, and the distance **should** never exceed 10 km on long stretches or according to national guidelines and operating context.

Figure 57: **Repeated signposting on long stretches**



Common Look & Feel advice:

— It is common that VSL is integrated in motorway control systems, where the variable speed limit signs are mounted above the carriageway. In these cases, VSL can be combined with, e.g. lane control and warning signs. The requirements and advice regarding VSL in this service description are still applicable but need to be combined with requirements and advice from other ITS Core services like TMS-01 (Dynamic Lane Management) and TMS-05 (Incident warning and Incident Management).

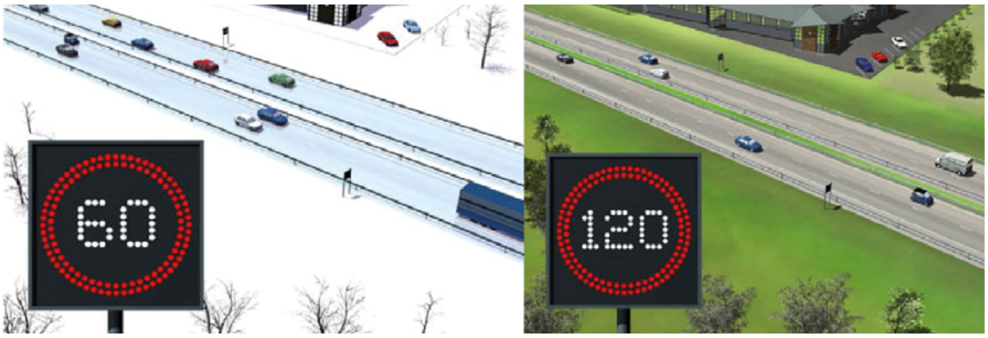
— Signs mounted above each lane can display different speeds for respective lanes, but only in limited cases and after proper testing and evaluation. In these cases, the greatest difference in speeds between adjacent lanes shall not exceed 20 km/h. This requires that the traffic management system algorithms perform separate calculations for each lane while respecting a maximum speed difference of 20 km/h between adjacent lanes throughout the length of the roadway segment.

— Side mounted VSL can remain in operation also when single lanes are closed. On the contrary, gantry mounted VSL over closed lanes can be switched off, unless they are used in a multilane control system where a red cross is displayed.
— Yellow flashing lights can be added to improve driver awareness of the set speed limit . In Motorway Control Systems yellow flashing lights can be used to alert the driver that he/she enters a section with a lower speed limit.

For road and weather condition controlled VSL, many different types of sensors can be used to monitor weather in general and road surface locally.

— For weather controlled VSL, automatic control with supervision from TMC operators ought to be used as much as possible. Much effort needs to be put into design of the weather control model and its algorithms. Note: National legislations may prevent road operators from using automatic weather controlled VSL.

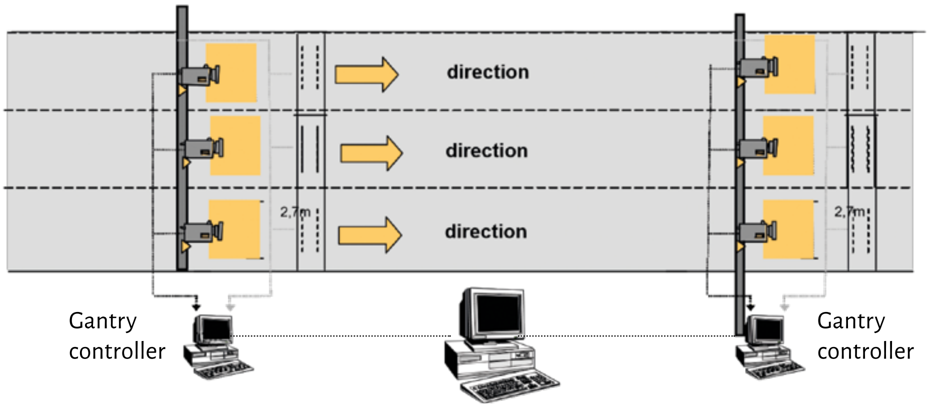
Figure 58: **Weather controlled VSL**



VSL on motorways

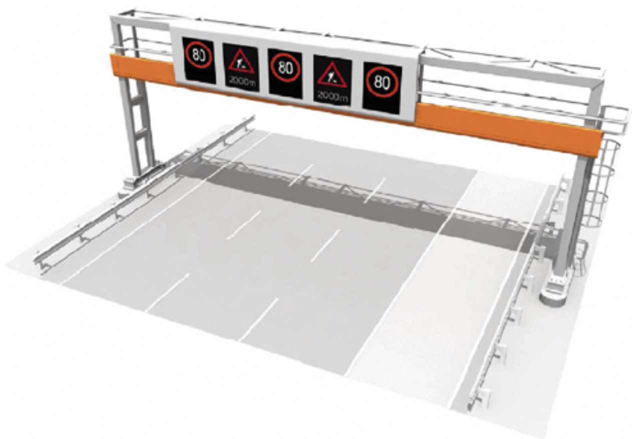
— For VSL on motorways, sensors are usually placed at each sign gantry. Inductive loops and microwave detectors are commonly used technologies. Also video, laser, light barriers and piezoelectric sensors are used.

Figure 59: **VSL on motorways**



— VSL on motorways are often automatic and based on sensor data. Manual override is used mainly in case of accidents or road works or, in wintertime, warnings concerning slippery and snowy roads. The algorithms should be designed both for increased throughput and safety ("queue warning function").

Figure 60: **Example of an Austrian line control system with variable speed limits and warning signs on a common gantry**



4.3.3.6 Required Standards and Specifications

Information provision standards

— **IPS1**: If a Variable Speed Limit service is implemented at interface 1 (see IFR1), it **must** be profiled based on CEN/EN 16157-3 using the DATEX II Recommended Service Profile for Speed Limits or any international machine-readable format fully compatible and interoperable with DATEX II.

— **IPS2**: If interface 2 is implemented, Variable Speed Limit information (see IFR2) **must** be profiled in an IVIM (Infrastructure to Vehicle Information Message) based on ISO 19321 using the C-ROADS C-ITS Message Profiles for the In-Vehicle Signage service, specifically the Traffic Sign Use Case.

— **IPS3**: When relevant, the Probe Vehicle Data (microscopic traffic situation) information (see IFR3) **should** be collected, which is profiled based on ETSI EN 302 637-2 using the CAR2CAR Communication Consortium Basic System Profile.

Variable message sign standards

— **SS1**: Discontinuous signs (i.e. LED) **must** follow the European standard EN 12966:2014+A1:2019 or their national counterparts. Continuous signs (retro-reflective, i.e. prism signs) must follow the European standard EN SS-EN 12899-1:2007 or their national counterparts where applicable.

Note: The standards allow several levels of performance to be selected due to i.e. the environment where the signs are used.

Standards for Fixed traffic signs

— EN 12899-1:2007 Fixed, vertical road traffic signs – Fixed signs. This standard can be partly used for continuous (retro-reflective) variable signs, like prism signs.

4.3.3.7 Level of Service definition

4.3.3.7.1 Level of Service criteria

Table 28 gives the Level of Service recommendations for a Variable Speed Limits service. The background of this concept is descripted in chapter 2.6.

Table 28: **Level of Service recommendations for Variable Speed Limits**

Levels of Service criteria table: Variable Speed Limits			
Core Criteria	**A**	**B**	**C**
Coverage	Spot coverage	Section coverage	Total corridor coverage (on critical sections along the corridor)
Level of coordination	No or limited coordination with other systems on section	Coordination with other TM measures for section control	
Monitoring / control	Manual monitoring	Clock and/or calendar control	Specific sensors monitoring

Coverage

— A - spot coverage: The VSL system covers only a short stretch of road where specific conditions prevail, for example hazardous intersection.

— B - Section coverage: The VSL system covers a longer stretch of road, but does not cover an entire corridor. A corridor in this case is the total road from one important point to another, e.g. between two cities.

— C - Total corridor coverage: The VSL system covers an entire corridor as described above.

Level of coordination

— A - No or limited coordination with other systems on a section. The VSL system does not operate in a coordinated way with other Traffic Management measures like hard shoulder running or lane signals.

— B - Coordination with other TM measures for section control: The VSL system is coordinated with other measures, often integrated in a Motorway Control System.

Monitoring and control

- A - Manual monitoring: Traffic Management staff change the speed limit manually when there is a need. The operators can either discover the problem through a CCTV system or get information from partners, like the police and rescue services.
- B - Clock and/or calendar control: The speed limit is set automatically bases on the time of day and/or year. This option is most suited for situations where you have daily or seasonal recurring problems.
- C - Specific sensors monitoring: Automatic control with sensors which detect the situation that calls for a reduced speed limit. This is generally the best solution, since it is not dependent on manual supervision and the displayed speed limit is in most conditions seen as relevant by the drivers.

4.3.3.7.2 Level of Service Criteria related to Operating Environment

Level of service requirement:

- **LoSR1**: In the case that pre-deployment surveys / evaluations provide the necessary evidence to proceed with the deployment of the ITS-service "Variable Speed Limits", the minimum and optimum LoS **should** respect the following Level of Service to Operating Environment mapping table.

Note: The Level of Service to Operating Environment mapping table is not an outcome of a specific scientific analysis but an expert view output.

Table 29: **Level of Service to Operating Environment mapping table (see also chapter 2.5.3 and ANNEX C)**

VARIABLE SPEED LIMITS			Operating Environment													
Criteria for the Level of Service			C1	T1	T2	T3	T4	R1	R2	R3	R4	S1	S2	N1	N2	P1
Coverage	C	Total corridor coverage (on critical sections along the corridor)											O		O	
	B	Section coverage	O		O	O	O			O	O	O	M	O	M	O
	A	Spot coverage	M						O							
	/	*No coverage*		NA	M	M	M	NA	M	M	M	M		M		M
Level of Coordination	B	Coordination with other TM measures for section control				O	O			O	O	O	O	O	O	O
	A	No or limited coordination with other systems on section	OM		O	M	M		O				M		M	
	/	*Service unavailable*		NA	M			NA	M	M	M	M		M		M
Monitoring / Control	C	Specific sensors monitoring	O		O	O	O			O	O	O	O		O	O
	B	Clock and/or calendar control							O					O		
	A	Manual monitoring	M			M	M						M		M	
	/	*Service unavailable*		NA	M			NA	M	M	M	M		M		M

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

4.4 TMS-03 Ramp Metering

4.4.1 ITS service at a glance

ITS service definition

Ramp Metering is a tool used to manage traffic at motorway junctions on a temporary basis usually during times of peak flow. Ramp metering is implemented via the installation of traffic signals at the on-ramps which regulate the flow of traffic joining the motorway or 'mainline' during peak or congested periods. It does this by controlling the discharge of vehicles from the on-ramp, holding vehicles back and breaking up platoons of vehicles, thus reducing the interference of merging vehicles and helping maintain the flow of traffic on the main carriageway. The traffic signals are generally operated in dependence of the currently prevailing traffic conditions on both the main carriageway and the on-ramp.

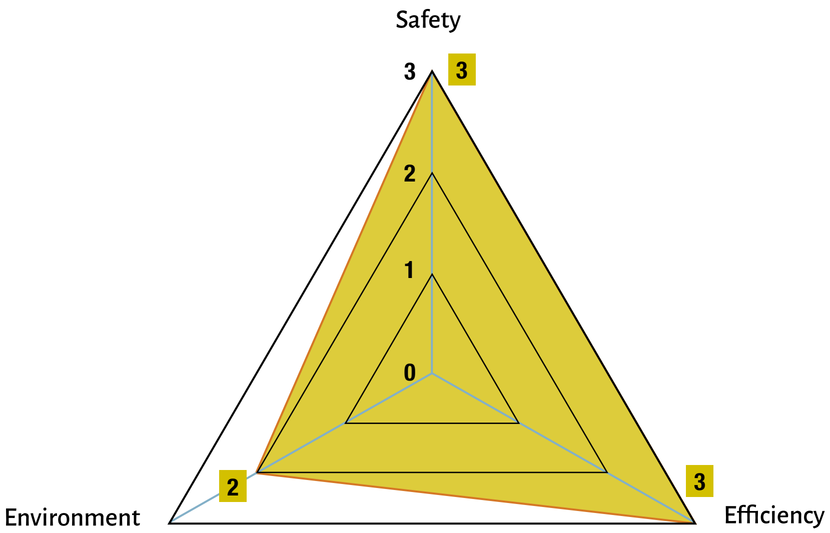
ITS service objective

The objective of ramp metering is to prevent or delay the onset of flow breakdown on the mainline, maximising throughput, without disrupting the surrounded urban road network. This is achieved by:

- Regulating the flow of additional traffic onto the motorway that, if unregulated would trigger flow breakdown / lead to critical shockwaves,
- Monitoring and managing the traffic flow on the on-ramp, achieving even distribution, to avoid large platoons of vehicles entering the motorway and causing flow breakdown and
- Reduction or avoidance of congestion spillback to the adjacent urban traffic network or to other merging motorways.

Ramp metering is not used directly to deter drivers making short trips but can have the added benefit that it will discourage drivers who do make short trips from using the motorway network.

ITS service radar



ITS service key words

Ramp, Mainline, Congestion, Management, Traffic Flow, Merge, Signal, Efficiency, Throughput

4.4.2 ITS service profile

4.4.2.1 General ITS service description

During peak or congested periods on the motorway, the addition of traffic from on-ramps causes vehicles to break or change lanes giving rise to higher occupancy and lower headways. Shorter headways cause drivers to reduce their speeds, resulting in a sustained loss of throughput.

This speed reduction often causes following vehicles to brake, resulting in a propagation wave of slowing vehicles that travels back along the line of traffic on the main carriageway upstream of the on-ramp. This speed adjustment can occur over a distance of up to 2 km prior to the on-ramp. During this time more vehicles will be attempting to join the main carriageway, and if vehicles continue to join, the speed on the main carriageway will fall to a point where flow breakdown occurs. Additionally, during peak periods when congestion is increased there may also be a higher risk of accidents.

Ramp metering (RM) is implemented via the installation of traffic signals on the on-ramps which regulate the flow of traffic joining the motorway during peak or congested periods. It does this by controlling the discharge of vehicles from the on-ramp, holding vehicles back and breaking up on-ramp platoons, thus reducing the interference of merging vehicles and helping maintain the flow of traffic on the main carriageway.

The traffic signals are generally operated in dependence of the currently prevailing traffic conditions on both the main carriageway and the on-ramps.

4.4.2.2 What is the vision?

From the operational perspective, the vision for ramp metering is effective control of on-ramp vehicles during congested periods, resulting in fewer accidents and maximised mainline throughput. If properly configured and controlled, the on-ramp control has minimal (and controlled) impact on the adjacent road network.

For drivers, encountering ramp metering in an unfamiliar area (i.e. another country) there would not be cause for anxiety as it has a similar look and feel; the driver knows what to expect and how to proceed. Drivers would accept that the small delay experienced on the on-ramp will mean safer, less congested conditions on the motorway.

There is sometimes a need for driver education where the use of ramp metering is new to a region, but essentially the ramp metering relies on the driver obeying mandatory traffic signals.

4.4.2.3 What is the mission?

The purpose of ramp metering is to prevent or delay the onset of flow breakdown on the main carriageway, maximising throughput, without disrupting the urban road network.
This is achieved by:

- Regulating the flow of additional traffic onto the motorway that, if unregulated would trigger flow breakdown / lead to critical bottlenecks,
- Monitoring and managing the traffic flow on the on-ramp, achieving even distribution, to avoid large platoons of vehicles entering the main carriageway and causing flow breakdown,

— Reduction or avoidance of congestion spillback to the adjacent urban traffic network or to other merging motorways.
— Ramp metering can also be used to deter drivers making short trips on the motorway and use the urban roads instead. Ramp metering is not used directly to deter drivers making short trips but can have the added benefit that it will discourage drivers who do make short trips from using the motorway network. Coordination with other road operators, urban authorities etc. is required.

Pre-signs and distinct traffic signal heads are used to indicate to drivers there is ramp metering in operation. Nevertheless, the systems rely on the driver obeying mandatory traffic signals as would be the case at any signalised junction.

4.4.2.4 Distinctiveness to other ITS services

Ramp metering is a traffic management measure designed to reduce the disruption from platoons of vehicles entering the main carriageway at on-ramps. The measure is characterised by:
— mainline and ramp traffic monitoring and control
— regulation of the flow of traffic entering the main carriageway via traffic signals positioned on the on ramp
— the use of algorithms to determine the required flow and thus the traffic signal timings
— the presence of traffic signal controls at locations, which might be seen as unusual by some drivers as there is no immediate evidence of traffic conflict as would usually be associated with signalised junctions.
— sometimes, decentralised control rather than central control from a Traffic Management Centre

Relevant complementary information, not included within this ITS service and covered by other ITS services, is:
— TTIS-01 and TTIS-02 pre-trip and on-trip Traveller Information: Information dissemination techniques employed by other motorway management functions may be used to inform to motorists en-route or pre-trip about the current operational status of ramp meters.
— TMS-06 Incident Warning and Management: Surveillance and incident warning systems can be used to determine and adjust ramp operational conditions. Data from detectors on the ramp or main carriageway can be used to adjust ramp metering parameters. CCTV can be used to verify that ramp meters are functioning optimally or to observe the effects of ramp metering on traffic flow. Incident management procedures and plans may be integrated with ramp metering to improve safety and restore operations on ramps and the main carriageway in a more timely fashion. Through active management of ramp meters, and other devices, operators may monitor motorway conditions during emergencies and clear on-ramp queues to allow a faster response to emergencies.
— TMS-04 Hard Shoulder Running and TMS-01 Dynamic Lane Management: Hard shoulder running and dynamic lane management may be used to direct motorists to use certain lanes and to merge out of other lanes. Ramp management strategies can be used in conjunction with lane use controls to manage the demand, leading to motorway sections where lane use controls are active.

4.4.3 Harmonization requirements and advice

4.4.3.1 ITS service definition

Ramp metering is implemented via the installation of traffic signals on the on-ramps which regulate the flow of traffic joining the motorway during peak or congested periods. It does this by controlling the discharge of vehicles from the on-ramp, holding vehicles back and breaking up on-ramp platoons, thus reducing the interference of merging vehicles and helping maintain the flow of traffic on the main carriageway. The traffic signals are generally operated in dependence of the currently prevailing traffic conditions on both the main carriageway and the on-ramps.

4.4.3.2 Functional requirements and advice

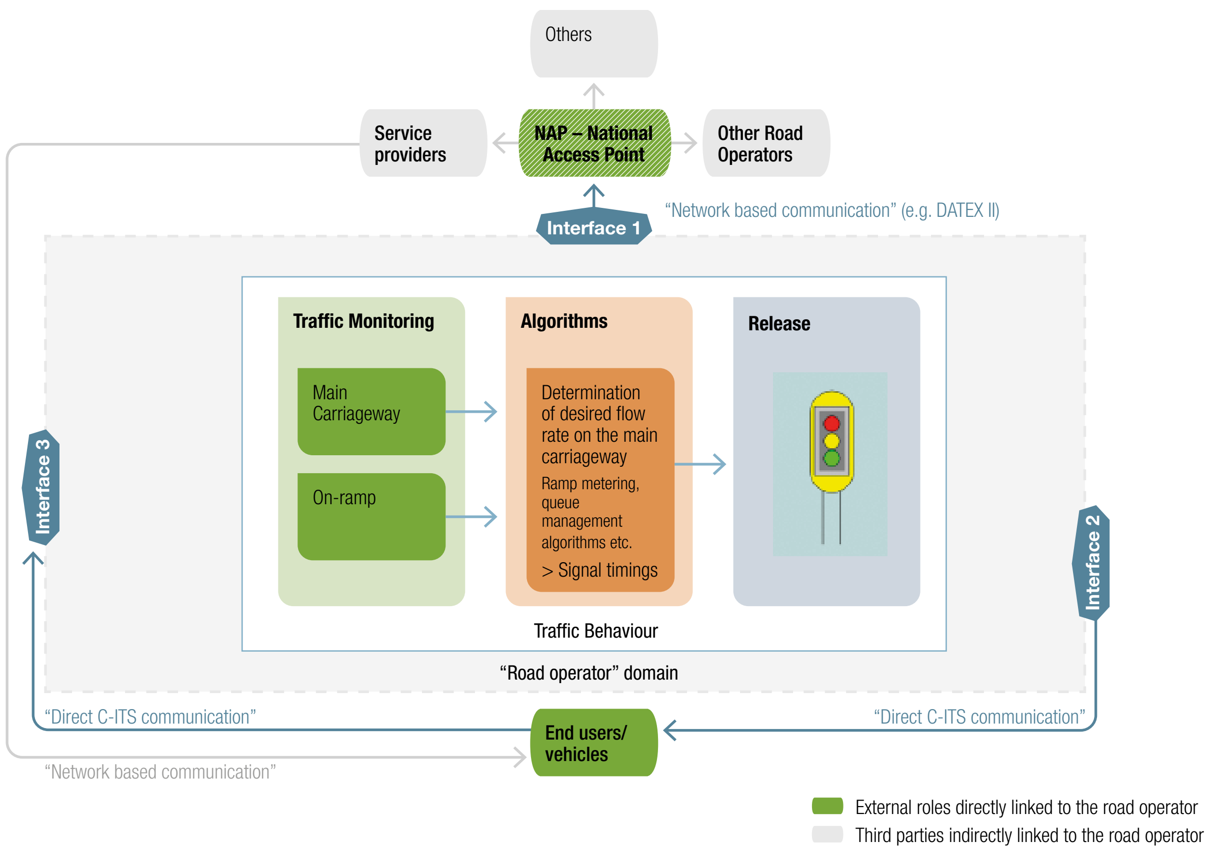
4.4.3.2.1 Functional architecture

The architecture for ramp metering service is made up of the following three functions:

- Monitoring of traffic situation on main carriageway (upstream and downstream of access point) and on-ramp
- algorithms to monitor and control the release rate
- and traffic signals to release the on-ramp traffic.

Figure 61 shows a simple situation together with three data communications interfaces which includes the potential for C-ITS service connectivity in the future. Importantly it illustrates the need to interface with a National Access Point in order to meet the obligations of the ITS Directive.

Figure 61: **Typical functional architecture of Ramp metering**



Cooperation with the adjacent network operators and their traffic control systems also need to be considered where appropriate. This can be achieved using a DATEX II reference profile.

4.4.3.2.2 Functional requirements and advice

- **FR1**: Automatic and semi-automatic systems **should** contain models and algorithms that calculate the traffic performance characteristics and transmit it to the ramp metering controller for activation as determined. These models and algorithms can be implemented in a central control system or at the roadside.
- **FR2**: The systems **should** have predefined handling of situations like power failure, disruptions in communications and other functional problems to avoid functional inconsistencies in the service. System parameters and error states **should** be disseminated in real-time to on duty staff.
- **FR3:** Traffic Management Centre Operators (or other dedicated resources) **must** be trained to supervise and manage the systems.
- **FR4**: When ramp metering interacts with other services such as hard shoulder running, or adjacent ramp metering systems, interfaces **should** be implemented either at roadsides or in central control systems.
- **FR5**: Sensors **must** be adapted to the service and give input to the control system. Note: Systems may include both manual and automatic functions as well as several types of sensors. This requires well defined hierarchical rules and priorities.
- **FR6**: Detector data updating frequency **should** be set correctly in order for the Ramp Metering System to receive enough quality data for the system to operate effectively and in the right circumstances.
- **FR7**: The traffic signals **must** display the stop/go light, that the control system has requested.
- **FR8:** Ramp metering using fixed release time **should** allow one vehicle per lane to pass during each release phase (green phase).
- **FR9**: When the signals are connected to are central control system, signals **should** report actively if activation was successful or not and send error messages if errors occur. Functionality (health) of the system **should** be monitored continuously.
- **FR10**: When connected to a central control system, Ramp metering **should** log all data about the performance of the technical systems and the impact on traffic flow and speed.

Functional advice:

- To be sure that the system is generating the required benefits, measures should be conducted within certain intervals.

4.4.3.3 Interface requirements

Interface requirements:

- **IFR1**: If the Ramp Metering service provides ramp metering information at interface 1 (see Figure 61), it **must** provide coded information including the following elements:
  - Location of the ramp metering, either as a linear section or as a group of points (i.e. the effected ramps)
- **IFR2**: If interface 2 is implemented, the Ramp Metering Service **must** provide at interface 2 (see Figure 61) Ramp Metering information coded in C-ITS messages including the following elements:
  - Signal phase
  - Location of the ramp metering

— **IFR3:** When relevant, the Ramp Metering Service **should** collect at interface 3 (see Figure 61) C-ITS coded Probe Vehicle Data information such as travel speed, direction, current location of a vehicle (microscopic traffic situation) relevant to this ITS Core service.

4.4.3.4 Organisational requirements and advice

Organisational requirements:

— **OR1:** Inter- and Intra-Agency Coordination - agreements and cooperation **should** be established between all authorities / operators when implementing ramp metering from one network to another (e.g. city authority urban roads to motorways or from one regional operator to another).

— **OR2:** Public Information Campaign – a formal public information campaign **should** be undertaken in areas where ramp metering is new.

4.4.3.5 Common look & feel requirements and advice

Common Look & feel requirements:

— **CL&FR1:** Ramp metering traffic signals **should** be positioned sufficiently far from the merging point to ensure drivers can accelerate enough to reach the speed of the main carriageway and to maximise the storage space on the on-ramp

— **CL&FR2:** The display of signs/pictograms on VMS or other end-user devices **should** be in accordance with prevailing national road codes and:

- Member States which ratified the Vienna Convention MUST respect the Vienna Convention and the European agreement supplementing the convention (1st May 1971) and SHOULD consider the Consolidated Resolution on Road Signs and Signals (R.E.2).
- Member States which did not ratify the Vienna Convention SHOULD follow the Vienna 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

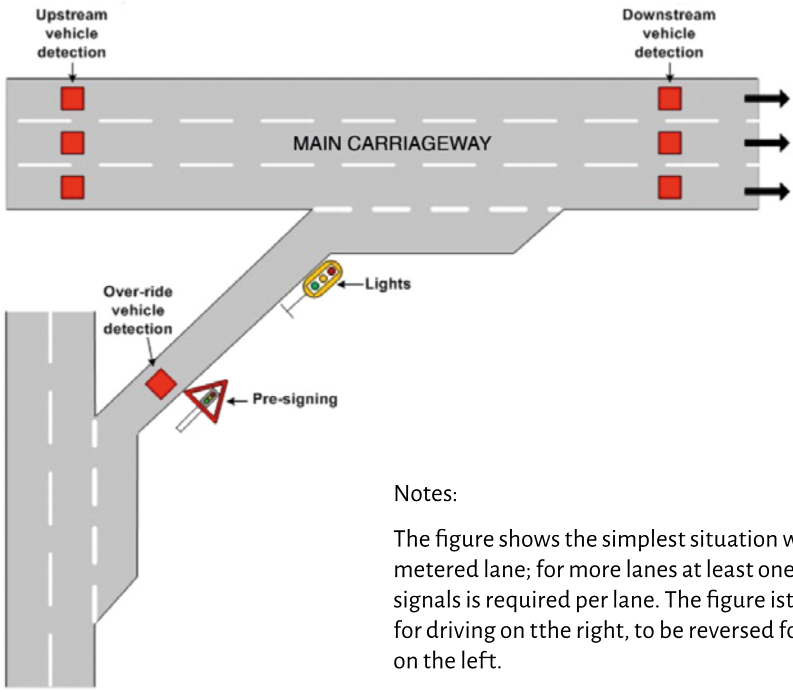
— **CL&FR3:** At least one set of traffic signals **should** be installed per lane

— **CL&FR4:** Ramp metering traffic signals **should** be installed at the metered on-ramps

— **CL&FR5**: Traffic signals may additionally be installed conform to national regulations

— **CL&FR6:** Fixed or variable warning pre-signs **should** be installed on the on-ramp sufficiently upstream of the traffic lights or the on-ramp entrance

Figure 62: **Example Infrastructure**



Notes:

The figure shows the simplest situation with one metered lane; for more lanes at least one set of signals is required per lane. The figure ist drawn for driving on tthe right, to be reversed for driving on the left.

- **CL&FR7:** The traffic signals **should** operate a “Green – Amber – Red” cycle
- **CL&FR8:** Ramp metering signals **should** be distinguishable from regular junction signals.
- **CL&FR9:** At locations where ramp metering is applied, the number of vehicles released **should** be communicated to the driver using static information panels stating: “ ‘x’ vehicle per green”.

Common look & feel advice:

- It is advised to install a contrasting yellow shield behind the traffic signals (Figure 63), as used in many European countries.

Figure 63: **Yellow backing shield**

4.4.3.6 ICT Infrastructure requirements and advice

Infrastructure advice

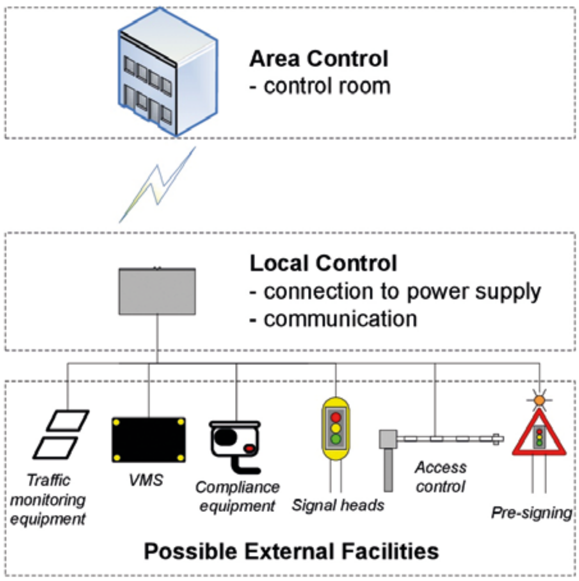
— System Architecture

It is advised that a 3-level system architecture is considered for ramp metering. The architecture can consist of the following elements, Figure 64.

- External facilities: can consist of detectors, video cameras, VMS and information panels, permanent illuminated signs, barriers, traffic signals
- Local control: local control station with data input/ output devices, connection to power supply and data communication

Area control: control (sub) centre is hierarchically structured and consists of optional control centre, control sub-centre and local control station.

Figure 64: **Ramp Metering System Architecture**



— Traffic Monitoring

The devices and methodologies for traffic data collection are not covered by this service description. They depend amongst others on the particular used data collection system and are left to the operator to select; provided a reasonable level of accuracy and reliability is guaranteed.

Usually there are vehicle detectors on the on-ramp and main carriageway to measures traffic conditions:

- Main carriageway detectors: the location of upstream and downstream detectors depends on the ramp metering algorithm requirements. In some cases, motorways are already equipped with a high density of traffic detectors (i.e. every 500m) or another real-time estimation system providing information on the current main carriageway traffic conditions. If this is the case, no additional detectors are needed.
- On-ramp detectors: these detectors are needed for queue management and traffic signal operation. For queue management purposes the number and location depends again on the chosen ramp queue management strategy.

— Local Controller / Outstation
  The outstation provides control functionality and calculates release rates and the resulting signal timings based on traffic flow. The outstation can be equipped with a remote communication so that administrative functions can be carried out remotely.
  Ramp metering controllers typically operate in the following states:
  - Standby mode – ramp metering lights are switched off
  - Activate – activate ramp metering and turn signals on
  - Steady state – state of "normal operation"
  - Queue override – prevents congestion on the local network, higher release rate
  - Deactivate - deactivate ramp metering and turn signals off
  - Fail-safe mode - prevents or mitigates unsafe consequences of the system's failure; depending on the situation this could be switching off or fixed-time control.

— The above states are described in many documents, EURAMP Deliverable 7.5 for example. The controller activates the ramp metering lights in accordance with the algorithms and contains an interface to traffic detectors (on the main carriageway and on-ramps).
  The specific combination of switching criteria and threshold values depends on the traffic conditions and control installation, i.e. the system may only be active as long as it is required by the traffic situation; when the traffic situation eases, the system goes into standby mode.

— Ramp Metering Algorithms
  Appropriate RM algorithms are used to monitor the traffic conditions and regulate traffic flow on the on-ramp onto the main carriageway. It is recommended that all algorithms are configurable.

— Fallback / Failsafe
  If signals or local controller fails, it is recommended that the central coordinated strategy be able to continue its operation and coordination of available ramps taking the missing ramp into account. If there are communication failures between the control system and the local controller should automatically switch to fail-safe mode.

— Communications
  Ramp metering systems require power supplies and telecommunication systems such as fibre optic cable or mobile/land-based telephone connections to provide links to the traffic operations centres and the signal controllers; remote communications are becoming more commonly used (sufficient bandwidth is required).

— Central Control System
  Operational Graphical User Interface (GUI): this is recommended to allow easy inspection, maintenance and repair of local signal controllers. A traffic operations centre GUI should allow for easy access to parameters, variables and display during operation. At times, analysis of historic variables may be required (i.e. in cases of errors or reconstruction of previous scenarios) and so archiving facilities are advantageous.

— Computing Devices
  The necessary computing devices may be centralised or decentralised depending on the adopted architecture. It can be of benefit if devices selected are easily scalable and have sufficient computing power to allow for future additions, updates and future strategy changes.

— Compliance with EU Delegated Regulations
  It is unlikely that the requirements of the EU Delegated regulations for road safety related traffic information and real-time traffic information services will impact greatly on this service. However, if data collected and processed results in safety information, or traffic management information being created which would be of use to the end user, the National Access Point must be used to publish the information.

4.4.3.7 Required standards and specifications

Information provision standards:

- **IPS1**: If the Ramp Metering service provides ramp metering information at interface 1 (see IFR1), it **must** be profiled based on EN 16157-3:2019 using the DATEX II Recommended Service Profile for Ramp Metering.
- **IPS2**: If interface 2 is implemented, Ramp metering information (see IFR2) **must** be profiled in an SPATEM/MAPEM (Signal Phase And Timing Extended Message/MAP Extended Message) based on ETSI TS 103 301 using the C-ROADS C-ITS Message Profiles for the Traffic Light Manoeuvre service.
- **IPS3**: When relevant, the Probe Vehicle Data (microscopic traffic situation) information (see IFR3) **should** be collected, which is profiled based on ETSI EN 302 637-2 using the CAR2CAR Communication Consortium Basic System Profile.

4.4.3.8 Level of Service definition

4.4.3.8.1 Level of Service criteria

Table 30 gives the Level of Service recommendations for a Ramp Metering service. The background of this concept is descripted in chapter 2.6..

Table 30: **Level of Service recommendations for Ramp Metering**

Levels of Service: Ramp Metering			
Core Criteria	**A**	**B**	**C**
Coverage	Spot coverage	Section coverage	Total route coverage on critical links on the network
Pre-signing	Fixed	Rotating Prism VMS	VMS
Metering Strategies	Fixed-Time	Local Response	Centralised System-Wide

The levels show technological advancement in the ITS solutions that can be implemented where appropriate; and can be cross-referenced to the Operating Environments.

The Levels of Service described here are not intended to indicate that by deploying Level C at all sites there will be improved results over Level B deployments, i.e. Level B is not "better" that Level A. The Levels only indicate advanced ITS technologies or techniques.

The Level of Service selected is closely related to the operating environment (traffic characteristics, level of incidents, road use etc.). As stated earlier, ramp metering is highly site specific in nature, i.e. Level A deployments may achieve the desire results in certain circumstances; but in other more complex situations another Level of Service may be more appropriate.

Using the table above, implementers can select the level of service of each element that is most appropriate, i.e. Level A Pre-signing with a Level 3 Metering Strategy.

Coverage

1: Point coverage – RM is deployed at on-ramps with a specific problem junction
2: Section coverage – RM is deployed at several junction on-ramps on a section

3: Wider route coverage – RM is deployed at on-ramps over longer routes where there are several bottlenecks / critical sections where congestion occurs

Pre-signing

1: Fixed signs - set number of vehicles per green / fixed operation time
2: Rotating prism VMS – allows changes in the number of vehicles per cycle based on current traffic conditions
3: VMS - provides maximum flexibility and can also be used to provide additional information to road users

Metering Strategies

The sophistication and size of a ramp metering system should reflect the amount of desired improvement and existing conditions. Ramp metering strategies can be based on fixed metering rates (historical), real-time data, or predicted traffic demand. Strategies can be implemented to optimise conditions locally or systemwide. Each control mode has an associated hardware configuration. If ramp control is linked at several junctions, there is greater overall equity. Distinguished by their responsiveness to prevailing traffic conditions, metering systems fall into three categories:

1: Fixed Time Operation
2: Local Traffic Responsive Operation
3: Centralised System-Wide Traffic Responsive Operation

4.4.3.8.2 Level of Service Criteria related to Operating Environment

Level of service requirement:

LoSR1: Given that pre-deployment surveys / evaluations provide the necessary evidence to proceed with the deployment of the ITS-service "Ramp Metering", the minimum and optimum LoS **should** respect the Level of Service to Operating Environment mapping table.

Table 31: **Level of Service to Operating Environment mapping table (see also chapter 2.5.3 and ANNEX C)**

RAMP METERING			Operating Environment													
Criteria for the Level of Service			C1	T1	T2	T3	T4	R1	R2	R3	R4	S1	S2	N1	N2	P1
Coverage	C	Route													O	O
	B	Section	O			O	O						O			
	A	Spot	M			M	M						M		M	M
Pre-signing	C	VMS	O													O
	B	Rotating Prism VMS				O	O						O		O	
	A	Fixed	M			M	M						M		M	M
Metering Strategies	C	Centralised System-Wide	O													O
	B	Local Response				O	O						O		O	
	A	Fixed-Time	M			M	M						M		M	M

Recommendatons for LoS per OE: M Minimum LoS recommended O Optimum LoS recommended

4.5 TMS-04 Hard Shoulder Running

4.5.1 ITS service at a glance

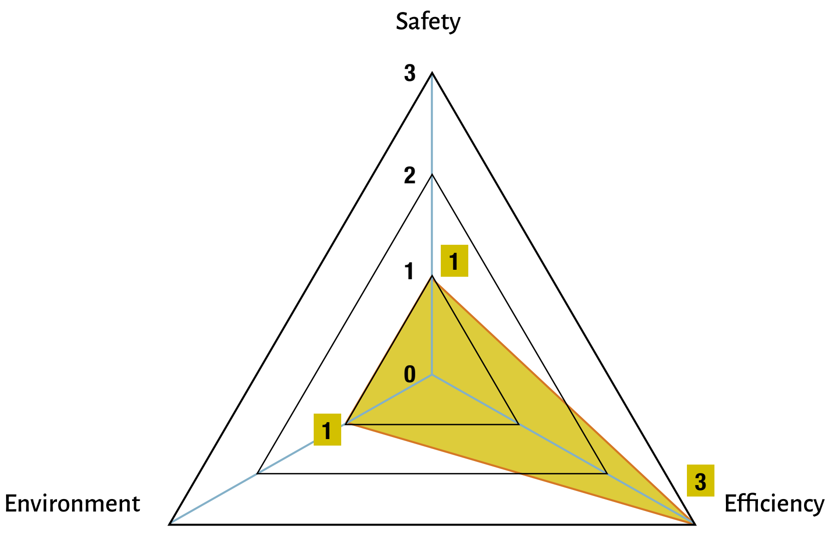
ITS service definition

Hard Shoulder Running (HSR) enables the dynamic temporary use of hard shoulders at road sections, including at junctions with the aim to increase road capacity when necessary. Hard Shoulder Running could be considered similar to the creation of an extra lane, but with specific safety issues due to the fact that a hard shoulder in common understanding is not available for general traffic use, and is sometimes replaced by refuges where road users can stop in an emergency or in case of breakdown.
Hard Shoulder Running is triggered by traffic demand, at fixed times or due to automated or manual requests and applied typically to bottlenecks, locations with poor safety records with a recurrent - but not constant - lack of capacity.

ITS service objective

The objective of Hard Shoulder Running is to increase road capacity on a section of the road network necessary, in order to minimize (heavy) congestion and to reduce the probability of congestion caused by incidents.

ITS service radar



ITS service key words

Hard Shoulder Running, HSR, Capacity, Congestion, Peak, Efficiency, Lane, Signal, Safety Protocols, Dynamic, Temporary, Demand Controlled

4.5.2 ITS service profile

4.5.2.1 General ITS service description

The hard shoulder running service enables dynamic temporary use of hard shoulders.

Hard Shoulder Running should only be implemented when the safety level remains the same or improves against the current operational mode. It can be applied on network areas, route sections and junctions prone to capacity problems. The capacity problems can be on a regular basis (e.g., Tuesday versus Friday, peak hour versus off peak hour) or for a longer period (major road works). The Hard Shoulder Running should cover the entire bottleneck, thus start at a junction with major entering flows and end at a junction with major flows leaving the road. Otherwise, the roads upstream and downstream of the HSR section may need to cope with extra capacity requirements as a result of potential higher demands.

The measures must include strict safety precautions in order to maintain the existing safety levels and can only be deployed if specific criteria are met, such as “no expected increase in emission levels”.

In a normal situation a hard shoulder has a specific set of users, mainly road users in emergency/ breakdown situations. Opening the hard shoulder to all road users can cause problems for emergency users and therefore their needs must always be considered.

Opening the hard shoulder for regular traffic without additional measures could give the hard shoulder an ambiguous character. This can cause confusing situations for road users, some examples of which include:
- A commuter accustomed to an open hard shoulder during peak hours, may also expect it to be open during off-peak hours and in lower volume peak hours in holiday periods.
- A commuter who is accustomed to an open hard shoulder during peak hours may use it while it is closed due to an emergency/breakdown situation downstream.
- Road users who are unaware you are allowed to drive on the hard shoulder will not adapt to a new lane, which can cause dangerous situations and under-utilisation of the hard shoulder lane by the user.

Good unambiguous instructions and education can counter these problems.

4.5.2.2 What is the vision?

The vision for use of Hard Shoulder Running is to increase road capacity on a necessary section of the road network, in order to minimize (heavy) congestion and to reduce the probability of congestion caused incidents. The level of throughput of traffic should increase due to the increase in road space.

4.5.2.3 What is the mission?

The mission for Hard Shoulder Running:
- is for bottlenecks/problem areas in the network with recurrent, but not constant, lack of capacity, i.e., recurrent peak hour congestion, to be eased and the benefits of extra capacity delivered to road users.
- to provide additional capacity without the need to undertake costly and often more time consuming permanent widening of the carriageway.

Hard Shoulder Running is similar to creating a dynamic extra lane triggered by traffic demand, at fixed times (peak hours) or even manually, and therefore requires dynamic traffic management control (see also TMS-01 Dynamic lane management). This extra lane is also to be controlled in the case of the use of the hard shoulder by a broken-down vehicle.

In specific cases Hard Shoulder Running:
— can be used to variably assign the lanes of the main carriageway and the exit ramp at the end of the Hard Shoulder Running segment (combination with Dynamic Lane Management).
— can be used to keep the number of lanes in case of left lane clearance ahead of working sites at the median
— can be referred to as peak hour lanes. It should be noted that these can also imply extra lanes, which are not necessarily hard shoulders
— can be conceived as an interim solution until an appropriate traffic solution is in place to counter capacity problems
— can be used for dedicated lanes, thus creating extra capacity for a dedicated set of road users like public transport (application case not covered by this service description, see also TMS-01 Dynamic lane management).

4.5.2.4 Distinctiveness to other ITS-services

Hard Shoulder Running is a special application of dynamic lane management. As a special service it interacts with the following other European ITS Core services:
— TMS-02 Variable Speed Limits
— TMS-01 Dynamic Lane Management
— TMS-06 Incident Warning and Management

Note: By applying Hard Shoulder Running, incident warning and management becomes very important and can become more complex. In this instance an extra step in the incident warning and management process is needed, i.e., to check if the hard shoulder is clear or can be cleared prior to opening of the hard shoulder to traffic. This also applies to ensure that proper winter maintenance has been carried out at winter time before opening the hard shoulder.

4.5.3 Harmonization requirements and advice

4.5.3.1 ITS Service Definition

Hard Shoulder Running enables the temporary use of hard shoulders along road sections. To achieve this overhead signals or signs at the roadside at regular intervals are used to indicate whether a hard shoulder is open for normal traffic. Furthermore, variable message signs are used to inform road user of current traffic conditions and in most cases the imposition of reduced speed limits which can be mandatory. Furthermore, lane signals at regular intervals - if present - can be used to indicate whether a hard shoulder is open for normal traffic.

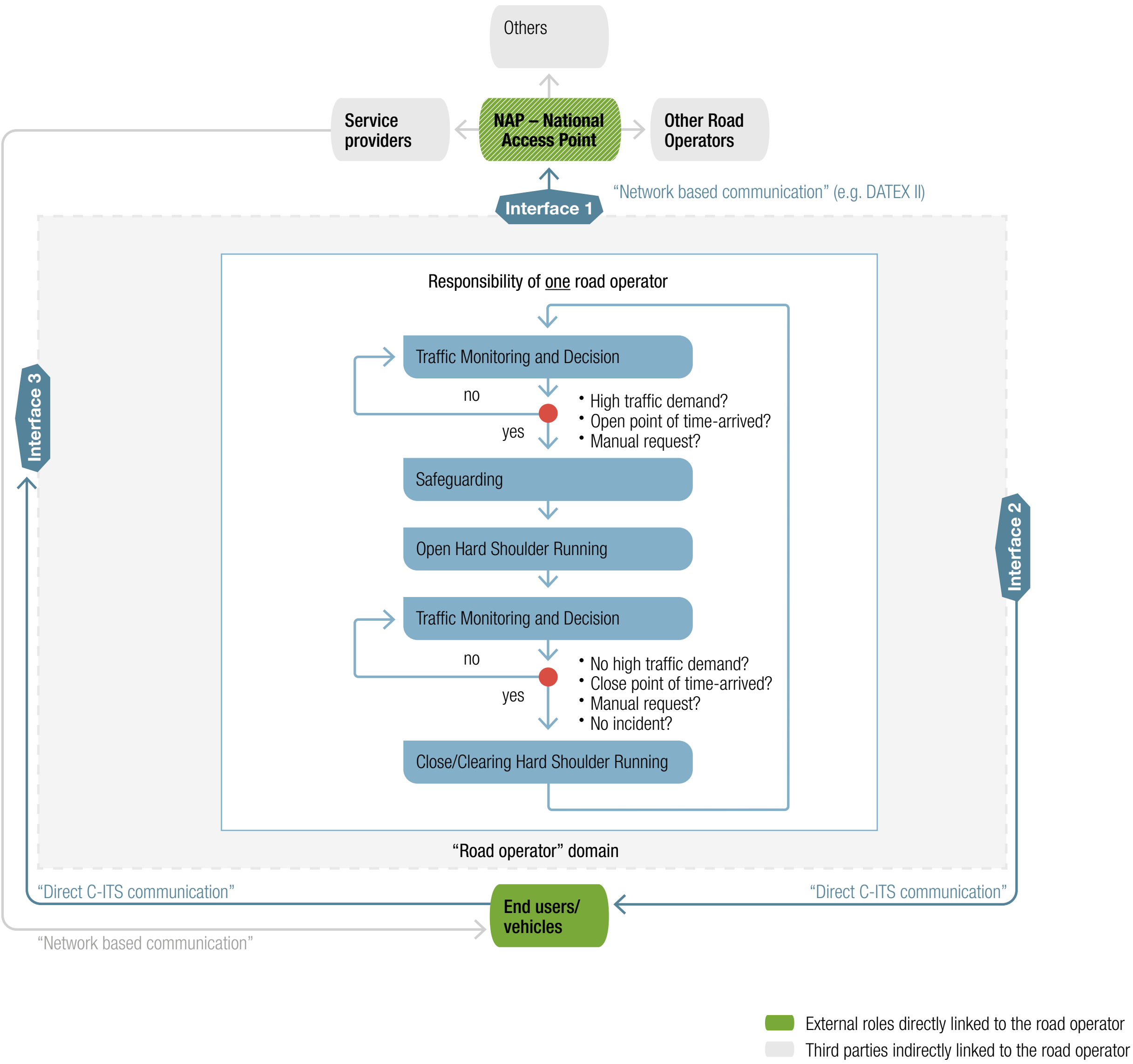
Hard Shoulder Running is triggered automatically by traffic demand, at fixed times or due to manual requests and applied to bottlenecks, locations with poor safety records with a recurrent - but not constant - lack of capacity.

4.5.3.2 Functional requirements and advice

4.5.3.2.1 Functional architecture

Figure 65 shows the typical functional architecture and control flow of a “Hard Shoulder Running Service”.

Figure 65: **Functional architecture and control flow of Hard Shoulder Running**



Hard Shoulder Running is carried out with a control algorithm or by using a manual request according to pre-determined traffic conditions such as high traffic demand.

Hard Shoulder Running is carried out via the following (illustrated by examples) processes:

— Monitoring - **Collect real-time information** on the traffic situation of the network or relevant/ chosen route sections.

— Safeguarding - **Check that the hard shoulder is unobstructed** for safe use. The hard shoulder must be free of debris, ice and snow, and vehicles obstructing safe use of the hard shoulder. Also, no road maintenance or road works can be conducted on the hard shoulder during periods of running.

- Information - **Inform road users that the hard shoulder is open for running**. Dynamic road signage provides road users with instructions that the hard shoulder is open for use.
  If a lane control system is available, active signage above each lane and the hard shoulder should be used. A symbol, such as a green arrow pointed downward and/or variable speed limit signs identifying open lanes and the allowed maximum speed, respectively, equally indicate that the hard shoulder is open for use; however, these symbol types (e.g. arrows or speed limits) cannot be used interchangeably at one location. Activated overhead signs dynamically indicate the total number of open lanes and whether the hard shoulder is open for use as an additional lane. Another option is the use of dynamic roadside signage to provide road users with instructions that the hard shoulder is open for use. Either option can be used or both can be used simultaneously to support the dynamic signage inform road users that the hard shoulder can be used for driving.
- Information - **Inform road users that the hard shoulder is closed or being closed**. If a lane control system is available, a yellow (flashing) arrow pointing diagonally downward is used as a transition signal to start the clearing process of hard shoulder. The clearing process can take place through a lane change along the extent of the road section and/or simultaneously via an exit ramp.

4.5.3.2.2 Functional requirements and advice

Functional requirements:

Safeguarding

- **FR1:** Incident detection and verification **must** be possible for the whole Hard Shoulder Running section. Incident detection does not need to be automated.
- **FR2:** Detection and verification time, as well as reaction time, **should** be as short as possible.
- **FR3:** Safety protocols and instructions **must** be documented and used to ensure the opening, running and closing of the Hard Shoulder Running is done safely.
- **FR4:** In case of failure of the Hard Shoulder Running signalization the system **must** be entered immediately into a safe state.
- **FR5:** Good quality surveillance and monitoring functions for traffic operators **should** be implemented.

Traffic monitoring and decision

- **FR6**: Before starting the Hard Shoulder Running opening/closing procedure, continuous traffic monitoring **should** be carried out along the entire section of Hard Shoulder Running including the hard shoulder as well as upstream and downstream road sections (network effects).

Functional advice:
The hard shoulder can also be used on a regular basis for specific type of vehicles, e.g. public transport. This application case is not covered by this “Hard Shoulder Running” service guideline. Further, there are examples within Europe where the hard shoulder has been converted for permanent running. This case is not covered by this guideline.

Feasibility study

Before implementation of a Hard Shoulder Running traffic management services a feasibility study will be able to answer the following questions:

— Is it necessary?
  Sometimes extra capacity is only needed for 2 or 3 hours one day of the week. The costs of implementing a scheme should not outweigh the benefits. Although HSR has become mature in some European Road Authorities, reduced speed limits when HSR is in operation can sometimes be perceived as a delay by drivers if there is no need for it. As such careful attention needs to be paid to the control algorithm to ensure the system is credible for road users.
— Will it benefit traffic flow on a network level?
  Studies of real-life systems show that an increase in capacity may only result in a limited impact on congestion, although journey times may become more reliable, and in some instances safety improved. Extra road attracts extra road users. Therefore, a comprehensive traffic analysis should be performed to ensure that the existing bottleneck is entirely addressed by the measure. Furthermore, simulation of the situation is recommended to ensure that the measure can cope with the demand in order to avoid negative network effects both upstream and downstream.
— It is allowed?
  Air and noise pollution legislative rules are strict (see also EU-legislation). Inhabitants in the area or a near extinct fauna or flora can put plans on hold for years.
— Is the hard shoulder construction suitable?
  Construction of the hard shoulder must be suitable for a heavy traffic load or construction may have to be improved and issues regarding drainage of water from the road surface must be solved.
— Is deployment safe?
  How is safety guaranteed or improved? Are, for instance, safeguarding protocols for the deployment of Hard Shoulder Running available and suitable? HSR will require formulation and use of a safety protocol for day-to-day operations.
— Does the network have sufficient capacity?
  The network must be able to cope with extra capacity demand both upstream and downstream. Increasing the capacity of a single stretch within the network, not considering upstream and downstream sections and intersection capacity, has only limited impact. Simulations of different scenarios are recommended.
— Does the road authority have capacity?
  Day-to-day operation of HSR will result in operational overhead often meaning additional staff and more comprehensive technical infrastructure which will need to be monitored and maintained.
— Do the Delegated Regulations under Directive 2010/40/EU have an impact?
  Delegated Regulation No 886/2013 addresses the need to provide road safety related minimum universal traffic information. Traffic management methodologies used for HSR will inevitably include use of VMS and other channels to communicate traffic management information and in doing so, safety related information such as an unprotected vehicle that is on the hard shoulder or elsewhere will need to be published by local or national access points (NAPs).
  Furthermore, Delegated Regulation No 2015/962 address the provision of real-time traffic information services published via a National Access Point. Introducing HSR will necessitate collection, use of, and communication of raw or processes data. Certain information will require wider publication via a NAP, which will also have the effect of improving the HSR traffic management services to end users.

Hard Shoulder scheme evaluation

Following implementation of an HSR scheme, evaluation of the scheme will indicate how successful the scheme has been and whether the HSR services should be expanded other otherwise.

Quantitative evaluation

To measure the impact of Hard Shoulder Running on safety, network efficiency and environment, it is necessary to collect data from the scheme using a proven methodology.

Suggested data for evaluation:

- Monitoring data
  - Congestion
  - Traffic volumes and speed
  - Work sites including maintenance work
  - Incidents
  - Weather conditions
  - Road conditions (snow, ice, oil, salt...)
- Logging of Hard Shoulder Running
  - Date
  - Start time/end time
  - Reason for releasing (opening) hard shoulder
  - Reason for closing hard shoulder
  - Congestion level
  - Speed limit
  - Average speed
  - Duration
- Logging failure notices
  - Failure of the systems
  - Switching command which has not been carried out
  - Improper command

Qualitative evaluation

- From a qualitative point of view questionnaires can be prepared and distributed in order to know road users' perception of safety and network efficiency. Compliance of the road user is relevant aspect of network efficiency. The percentage of vehicles driving on the hard shoulder determines the extra capacity."
- Road operators could also be addressed with such questionnaires, differently formulated, in order to share their experiences on the impact of the dynamic allocation of lanes on the environment, safety and traffic flows.

4.5.3.3 Interface requirements

Interface requirements:

- **IFR1**: If the Hard Shoulder Running service provides hard shoulder information at interface 1 (see Figure 65), it **must** provide coded Hard Shoulder Running information including the following elements:
  - Location (section) of the Hard Shoulder Running section
  - Status of the hard shoulder (open/close)
  - Speed limit
  - Type of vehicles

- **IFR2**: If interface 2 is implemented, the Hard Shoulder Running service **must** provide at interface 2 (see Figure 65) Hard Shoulder Running information coded in C-ITS messages including the following elements:
  - Allocation and spatial dimension of the Hard Shoulder Running section
  - Road signs for Hard Shoulder Running (HSR is open, HSR is clearing)
  - Road signs for variable speed limit
  - Type of vehicles
- **IFR3:** Incoming DENM from end users/vehicles are checked for safety-relevant facts that lead to the HSR being switched off or prevented from being switched on (e.g. stationary vehicles on the hard shoulder, obstacles on the hard shoulder lane). When relevant, the Hard Shoulder service **should** collect at interface 3 (see Figure 65) C-ITS coded Probe Vehicle Data information such as travel speed, direction, current location of a vehicle (microscopic traffic situation) relevant to this ITS Core service.

4.5.3.4 Organisational requirements and advice

In general, it is necessary for national and European law and legislation to allow for the use of hard shoulders (AGR- European agreement on international main arteries, Annex II, section III.3.2).

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

Organisational advice:

Introducing HSR can raise safety concerns amongst police and road user communities. It is suggested that a dialogue is opened with key stakeholders at an early stage of evaluation and planning to enable them to give their specialist input. It is recommended that a pilot scheme is first introduced to allow learning from the scheme and adaptations to be made for incorporation into future deployment of HSR schemes.

4.5.3.5 Common Look & Feel requirements and advice

Common Look & Feel requirements:

- **CL&FR01:** The display of signs/pictograms on VMS or other end-user devices **should** be in accordance with prevailing national road codes and:
  - Member States which ratified the Vienna Convention MUST respect the Vienna Convention and the European agreement supplementing the convention (1st May 1971) and SHOULD consider the Consolidated Resolution on Road Signs and Signals (R.E.2).
  - Member States which did not ratify the Vienna Convention SHOULD follow the Vienna Convention and also consider the R.E.2.

Common Look & Feel advice:

Driver information:

- The road user should be informed on the road, but also in a general way, of the goals and functionality of Hard Shoulder Running services.
- Lane colouring: In order to emphasize the presence of the lane for Hard Shoulder Running, a different colour of the tarmac may possibly be applied.

Common Look & Feel requirements:

- **CL&FR02:** Safe havens/ERAs **should** be provided in order to create safe zones for broken down vehicles.
- **CL&FR03:** Safe havens/ERAs **should** ensure a safe use (length and width).
- **CL&FR04:** The maximum distance between safe havens/ERAs **should** be 1000m.
- **CL&FR05:** Road markings at junctions and cross sections **should** be in line with general standards used for road sections without Hard Shoulder Running.
- **CL&FR06:** Indications for an open or closed hard shoulder **should** be located at a distance which ensures the road user has good visibility of the successive signals/signs along the relevant stretch of road.

Hard Shoulder Running signage

- Messages that should be conveyed to the road user through VMS, in car data or other means:
  - Hard shoulder is closed (CL&FR07)
  - Hard shoulder is open (CL&FR08)
  - Hard shoulder is clearing (CL&FR09)
  - End of the hard shoulder section (CL&FR10)
  - Applicable speed limit (mandatory or otherwise)
  - Adjustable direction signs (if overhead signs show the number of lanes)

Note: In some cases, the use of static signs can be sufficient. This is an option for Hard Shoulder Running that is used at set times (i.e. weekdays – 7:00-9:00)

Common Look & Feel requirements:

- **CL&FR07:** Hard shoulder is closed **should** be displayed according to either Figure 66 or Figure 67
- **CL&FR08:** Hard shoulder is open **should** be displayed according to either Figure 68 or Figure 69
- **CL&FR09:** Hard shoulder is clearing **should** be displayed according to either Figure 70 or Figure 71
- **CL&FR10:** End of hard shoulder section **should** be displayed according to either Figure 72 or Figure 67

Figure 66: **Variable message signs for CL&FR07-1**

CL&FR07–1	Options HSR is closed
Look of sign	Sign empty
Where	on the side of the road or over the lane on a gantry
When	at the start of the HSR section
Example	

Figure 67: **Support through dynamic lane management systems for CL&FR07-2 and CL&FR10:**

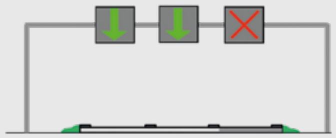
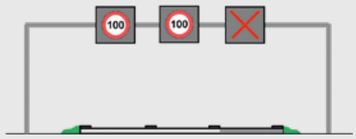
CL&FR07–2	Options HSR is closed	
Look of sign	Green arrows above regular lanes + a red cross	Speed limit above regular lanes + red cross above hard shoulder
Where	Yellow / white bulbs	
When	When hard shoulder is closed	When hard shoulder is closed
Example		

Figure 68: **Variable message signs for CL&FR08-1**

CL&FR08–1	Options HSR is open	
Look of sign	Sign "E, 20a" Vienna convention (number of arrows corresponding with number of lanes)	Sign "E, 20a" Vienna convention + speed limit (number of arrows corresponding with number of lanes)
Where	on the side of the road or over the lane on a gantry	on the side of the road
When	at the start of the HSR section	at the start of the HSR section
Example		

Figure 69: **Support through dynamic lane management systems for CL&FR08-2**

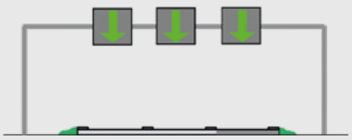
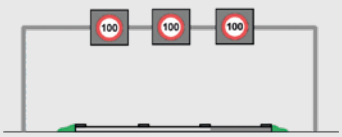
CL&FR08–2	Options HSR is open (a combination of both is an option)	
Look of sign	green arrow	speed limit
Where	Above all lanes	Above all lanes
When	At least every 1 km	At least every 1 km
Example		

Figure 70: **Variable message signs for CL&FR9-1**

CL&FR09–1	Options HSR is clearing	
Look of sign	Sign “E, 20b” Vienna convention (number of arrows corresponding with number of lanes)	Sign “E, 20b” Vienna convention + speed limit (number of arrows corresponding with number of lanes)
Where	on the side of the road or over the lane on a gantry	on the side of the road
When	Before the end of the HSR section	Before the end of the HSR section
Example		

Figure 71: **Support through dynamic lane management systems for CL&FR9-2**

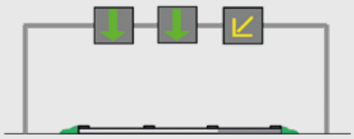
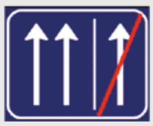
CL&FR09–2	Option HSR is clearing
Look of sign	Yellow / white tilted arrow (with or without flashing lights) + green arrows
Where	Yellow / white tilted arrow above HSR lane
When	Before the end of the HSR section
Example	

Figure 72: **Variable message signs for CL&FR10**

CL&FR10	Options end of HSR section	
Look of sign	Sign “E, 20c” Vienna convention (number of arrows corresponding with number of lanes)	Sign “E, 20c” Vienna convention + speed limit (number of arrows corresponding with number of lanes)
Where	on the side of the road or over the lane on a gantry	on the side of the road
When	At the end of the HSR section	At the end of the HSR section
Example		

4.5.3.6 Required standards and specifications

Information provision standards:

— **IPS1**: If a Hard Shoulder Running service is implemented at interface 1, the information (see IFR1) **must** be profiled based on EN 16157-3:2019 using the DATEX II Recommended Service Profile for Hard Shoulder Running.

— **IPS2**: When relevant, Hard Shoulder Running information (see IFR2) **should** be profiled in an IVIM (infrastructure to vehicle information message) based on ISO 19321 using the C-ROADS C-ITS Message Profiles for the In-Vehicle Signage service.

— **IPS3**: When relevant, the Probe Vehicle Data (microscopic traffic situation) information (see IFR3) **should** be collected, which is profiled based on ETSI EN 302 637-2 using the CAR2CAR Communication Consortium Basic System Profile.

4.5.3.7 Level of Service definition

4.5.3.7.1 Level of Service Criteria

Table 32 gives the Level of Service recommendations for a Hard Shoulder Running service. The background of this concept is descripted in chapter 2.6.

Table 32: **Level of Service recommendations for Hard Shoulder Running**

Levels of Service criteria table: Hard Shoulder Running			
Core Criteria	**A**	**B**	**C**
Road signing	Manually on site	Dynamic prism/VMS	-
Monitoring	Manually through traffic officers and/or police	Semi-automatic via traffic officers and/police and camera's	Automatic through cameras, loops, sensors
Safeguarding	Physical	Physical and through cameras	Physical and through cameras + Automatic detection
Activation and deactivation (decision and action)	Manually and manually on site	Manually and remote controlled	Manually, based on decision support systems and remote controlled
Enforcement*	Physical and periodical	Semi-automatic	Automatic
Note: Hard Shoulder Running can be carried out in a first stage or in the case of very rare applications, by the police / traffic officers without technical installations. ***Note:** "Enforcement" should be considered a complementary criterion in the identification of the level of deployment, depending on national or regional policies and local characteristics of the service implementation. The "enforcement" criteria should not be considered as critical or mandatory while achieving a level of service.			

4.5.3.7.2 Level of Service Criteria related to Operating Environment

Level of service requirement:

— **LoSR1**: In the case that pre-deployment surveys / evaluations provide the necessary evidence to proceed with the deployment of the ITS-service "Hard Shoulder Running", the minimum and optimum LoS **should** respect the following Level of Service to Operating Environment mapping table.

Table 33: **Level of Service to Operating Environment mapping table (see also chapter 2.5.3 and ANNEX C)**

HARD SHOULDER RUNNING			Operating Environment													
Criteria for the Level of Service			C1	T1	T2	T3	T4	R1	R2	R3	R4	S1	S2	N1	N2	P1
Road signing	C	–														
	B	VMS	O			O	O			O	O		O			O
	A	Fixed	M	NR	NR	M	M	NR	NR			NR	M	NR	NR	M
Monitoring	C	Automatic through cameras, loops, sensors VMS	O										O			OM
	B	Semi-automatic via traffic officers and/police and camera's				O	O			O	O		M			M
	A	Manually through traffic officers and/or police	M	NR	NR	M	M	NR	NR	M*	M*	NR		NR	NR	
Safeguarding	C	Physical and through cameras + Automatic detection											O			O
	B	Physical and through cameras	O			O	O			O	O		M			M
	A	Physical	M	NR	NR	M	M	NR	NR	M*	M*	NR		NR	NR	
Activation and deactivation (decision and action)	C	Manually, based on decision support systems and remote controlled											O			O
	B	Manually and remote controlled				O	O			O	O		M			M
	A	Manually and manually on site	M	NR	NR	M	M	NR	NR	M*	M*	NR	M	NR	NR	M

Recommendatons for LoS per OE:

M	Minimum LoS recommended	O	Optimum LoS recommended
M*	Non relevant for two-lane roads		
OM	Minimum = Optimum	NR	Non relevant

4.6 TMS-05 HGV Overtaking Ban

4.6.1 ITS service at a glance

ITS service definition

An HGV Overtaking ban service means to channel the heavy goods vehicles onto a single lane (slow lane).
The heavy goods vehicles overtaking ban implementation is one of the traffic management measures allowing traffic managers and road operators to propose solutions for a better fluidity of their network during peak periods. This traffic control measure constitutes one of the priority services to improve the cohabitation of heavy goods vehicles and private cars on networks with high levels of traffic.

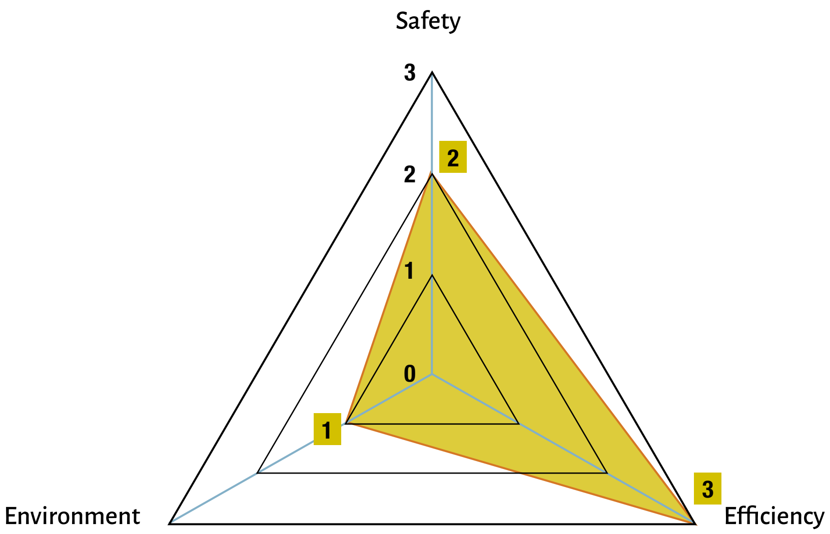
ITS service objectives

Objectives:

- Monitor and manage the HGV traffic flow on the motorway network
- Reduce journey times for light vehicles
- Improve safety by reducing the number of lane changes and vehicle queues caused by slow lorries overtaking
- Ensure a better acceptance of heavy goods vehicles by the other road users.

The service allows traffic managers and road operators to support better fluidity on the network during peak periods.

ITS service radar



ITS service key words

- HGV, Overtaking Ban

4.6.2 ITS service profile

4.6.2.1 General ITS service description

During peak or congested periods on the main carriageway, HGV Overtaking may cause vehicles to brake or change lanes, creating higher occupancy and lower headways. This causes drivers to reduce their speed.

This speed reduction often causes following vehicles to brake, resulting in a propagation wave of slowing vehicles that travels back along the line of traffic on the main carriageway upstream where the HGV overtakes.

Traffic congestion on the network due to HGV overtaking with a low speed differential results in traffic slowdown in the middle and/or left lanes. The major impact is a decreased capacity of the network.

Additionally, during peak periods when congestion is increased there may also be a higher risk of accidents.

The HGV overtaking ban service is implemented through the deployment of ban signals on the main carriageway. This service intends to organize flow of heavy goods vehicles on the motorway network by channelling them onto a single lane (slow lane) in order to improve the traffic flow conditions.

4.6.2.2 What is the vision?

Public opinion considers that heavy goods vehicles are dangerous and disturb the traffic when overtaking. This requires research for means to improve journey times and safety by reducing vehicle queues caused by slow lorries overtaking while ensuring a better acceptance of heavy goods vehicles by other road users.

Heavy goods vehicles overtaking ban implementation on long distances (several kilometres) is a traffic management measure enabling traffic managers and road operators to propose solutions for better fluidity of their network during peak periods. This measure constitutes one of the priority services to improve cohabitation between heavy goods vehicles and private car drivers on high traffic networks.

The overtaking ban is implemented during periods where the network capacity reaches its saturation point or when trucks are too numerous. According to the context and objectives, the deployment of overtaking ban can be managed in static way (the overtaking can be permanent or intermittent) or in dynamic way.

Recommendations and requirements presented in chapter “Harmonization requirements and advice” of this ITS service description mainly concern the dynamic overtaking ban service.

The deployed HGV overtaking ban intends to:
— Monitor and manage the HGV traffic flow onto the motorway network,
— Shorten journey duration and increase safety for personal vehicles by reducing queues caused by slow lorries overtaking,

— Reduce CO_2 emission
— Ensure a better acceptance of heavy goods vehicles by other road users.

An HGV overtaking ban can be deployed on 2 and 3 lane (or more) highways. Nevertheless, due to national regulations, such a service is only allowed on 2 lane highways in some countries (Netherlands for example).

The deployment of an HGV overtaking ban is generally assessed against the following parameters:
— network typology (number of entrances and exits, slopes, etc.),
— percentage of HGVs,
— number of HGVs,
— traffic flow,
— period (in some countries no ban is issued during the weekend)

4.6.2.3 What is the mission?

Take into account national regulations to implement the ban:
— Different political situations and objectives among actors to implement the ban

Define the strategy for implantation of the ban according various parameters:
— network typology (number of entrances and exits, slopes, etc.),
— percentage of HGVs,
— number of HGVs,
— traffic flow,
— period (in some countries no ban is issued during the weekend)

4.6.2.4 Distinctiveness to other ITS services

In practice, an HGV overtaking ban is part of a larger integrated traffic management system including others service as:
— Hard shoulders running
— Dynamic lane management
— Variable speed limit Dynamic
— Dynamic incident warning

Relevant complementary information, which is not the content of this service description and will be covered by other DGs, is:
— Pre-trip and on-trip information services which may be used to inform on-trip or pre-trip users about the current operational status of the HGV overtaking ban (see TIS DG01-DG02).
— Recommendations about VMS According Vienna convention
— Information provision should be coordinated with traffic management plans (TMP, see TMS-07) operated by road authorities or traffic management centres.

4.6.3 Harmonization requirements and advice

4.6.3.1 ITS service definition

An HGV Overtaking ban service means to channel the heavy goods vehicles in a single lane (slow lane). This measure improves the traffic flow conditions by reducing vehicle queues caused by slow HGV overtaking. It also contributes to ensuring a better acceptance of heavy goods vehicles by the other road users.

The heavy goods vehicles overtaking ban implementation is one of the traffic management measures allowing traffic managers and road operators to propose solutions for a better fluidity of their network during peak periods. This traffic control measure constitutes one of the priority services to improve the cohabitation of heavy goods vehicles and private cars on networks with high traffic levels.

4.6.3.2 Functional requirements and advice

4.6.3.2.1 Functional architecture

Figure 73: **Interface architecture of the HGV Overtaking Ban service**

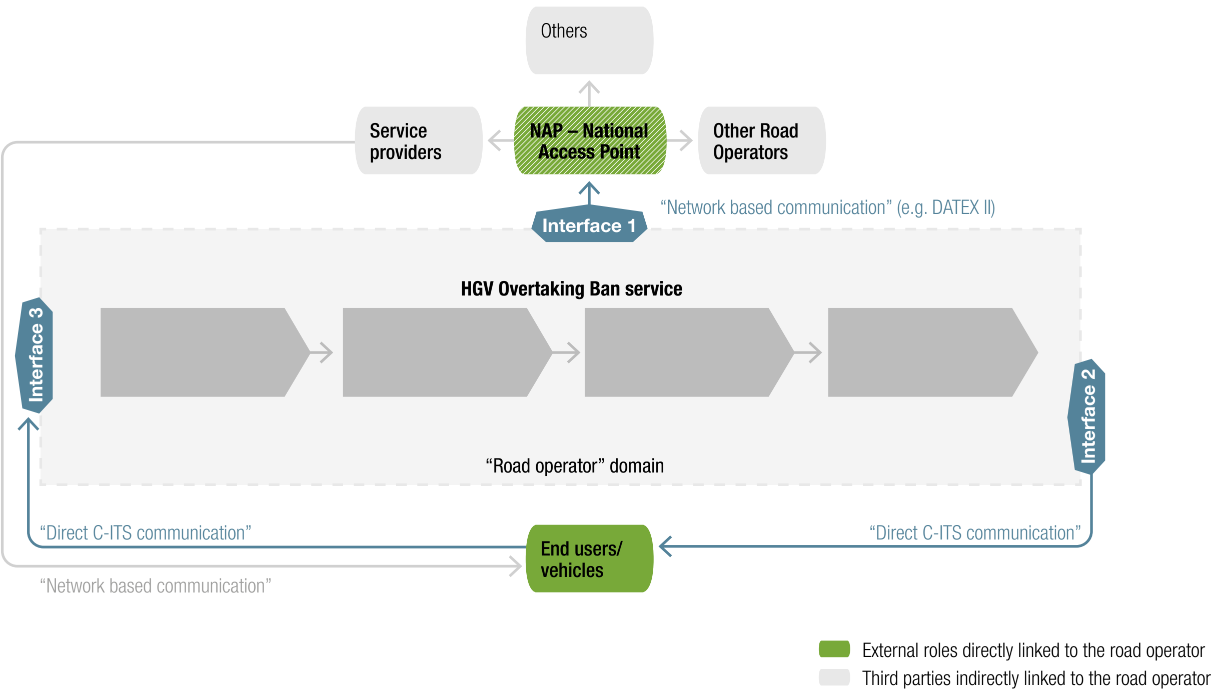
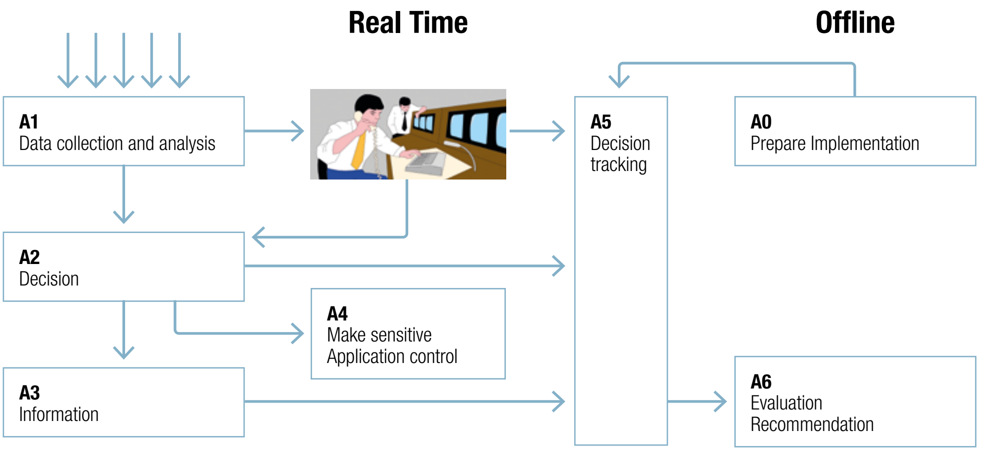


Figure 74 shows the typical functional and information architecture of the HGV Overtaking ban service.

Figure 74: **Functional architecture of the HGV Overtaking Ban service**



4.6.3.2.2 Functional requirements and advice

Functional requirement:

— **FR1:** it is recommended to prepare HGV Overtaking ban service implementation with an easy functional decomposition. The proposed seven sub functions **may** be followed when implementing the service.

Table 34: **Sub-Functions of the HGV Overtaking Ban service**

A0	Prepare the HGV Overtaking ban implementation
A1	Collect and analyse data transmitted from monitoring systems
A2	Decide the relevant HGV Overtaking ban implementation strategy to apply
A3	Inform partners and users about implementation
A4	Make the users aware of the measure and enforce the implementation
A5	Track the decision for assessment use
A6	Evaluate and assess, measure the impacts in order to provide recommendation and improvement

The devices and methodologies for traffic data collection are not covered by this guideline. They depend, among other things, on the particular data collection system used and are left to the operator to select.

Functional requirement:

— **FR2:** for the dynamic service it is recommended that the data collection system **should** be able to detect real-time traffic data (e.g. vehicle flow, speed and HGV% per lane).

4.6.3.3 Interface requirements

- **IFR1**: If the HGV Overtaking Ban service provides HGV Overtaking Ban information at interface 1 (see Figure 73), it **must** provide coded information including the following elements:
  - Location (section) of the HGV overtaking ban
  - If applicable the affected lanes (esp. on carriageways with more than two lanes)
  - If applicable a specification of the affected vehicles (e.g. characterised by their weight)
  - Start time, and, if applicable, the end time of the HGV overtaking ban.
- **IFR2**: If interface 2 is implemented, the HGV Overtaking Ban service **must** provide at interface 2 (see Figure 73) HGV Overtaking Ban information coded in C-ITS messages including the following elements:
  - the respective road sign for the overtaking ban
- **IFR3:** When relevant, the HGV Overtaking Ban service **should** collect at interface 3 (see Figure 73) C-ITS coded Probe Vehicle Data information (microscopic traffic situation) relevant to this ITS Core service.

4.6.3.4 Organisational Requirements

Depending on the traffic conditions and periods, the objectives of an HGV overtaking ban could be to:
- Improve network fluidity,
- Improve safety,
- Improve user comfort.

Whatever the initial objectives, the anticipated benefits of the service rely on stakeholders' involvement for its implementation and road users' acceptance on the network.

Organisational Architecture

Figure 75: **Organisational architecture of the HGV Overtaking Ban service**

Organisational requirement:
- **OR1:** the organisational and operational structure of the service, as well as the role of each organisation/body and its tasks, **must** be compliant with the National Access Points across Europe, within the scope of the implementation of the delegated acts adopted under Directive 2010/40/EU

Organisational advice:
The service implementation requires the involvement of various organisations which are in charge of the following general roles:

- **Road authorities**

For the HGV overtaking ban the subsidiarity principle applies, i.e. Member States decide for themselves whether and how a truck overtaking ban is applied. The road authorities are responsible for the decision and the deployment of the service. They have to conduct preliminary studies:

- Launch a detailed traffic study in order to define exactly the area where the service will be implemented,
- Identify the level of accidents on the network (with regard to HGV involvement)
- Identify the existing collection systems, control systems and information systems
- Identify the existing HGV ban regulations and constraints regulation for implementing the service
- Select the sections where the ban will be implemented
- Validate the thresholds for the strategy activation (permanent, intermittent, dynamic)
- Study and estimate the necessary additional equipment and systems to install
- Plan the organisational and technical aspects of the evaluation
- Involve partners
- Launch communication actions
- Establish the administrative and regulation procedures before installing such a ban on the network.

— **Road operators**

Following decisions taken by the road authorities they are mainly responsible for:

- conducting the relevant studies,
- implementing the technical equipment and systems,
- recording data for evaluation purposes,
- informing partners when the ban is operated (especially Police) in the case of dynamic bans,
- informing service operators when the ban is operated.

Organisational requirement:

— **OR2:** In the case where road operators have to exchange data requiring interoperability between two or more different organisations[33], they **must** enable their system to use DATEX II".

Organisational advice:

— **Law and order forces**

Police are mainly responsible for HGV overtaking ban enforcement. In the case of permanent or intermittent bans they can plan enforcement actions of their own.

Nevertheless, dynamic ban implementation requires specific information actions from the Road operators: the ban is only operational when thresholds for strategy activation are reached. In the case of enforcement implementation, Police patrols need to be informed by road operators in real-time in order to plan intervention. Enforcement may concern different types of control:

- HGV overtaking ban compliance
- Speed compliance
- Inter-vehicle distance respect (mainly for HGV)

HGV representatives

Positive impacts of the service result from respect of the ban by HGV drivers. Such a measure requires coherent communication actions towards HGV representatives. In the case of dynamic bans, road operators manage real-time on-trip information through VMS, dedicated road traffic radio, on-board devices. It is important to stress the benefits of accident savings and the very small increase to journey times for HGVs to HGV operators and drivers.

HGV representatives have to be engaged as soon as possible in the ban process so that they can facilitate information transfer to their HGV drivers.

33 In the TTIS context, 'organisations' mean Traffic and Traveller Data providers and Service providers.

Media

Operators inform users of the existence of the measure(s), along with its interest and objectives, in order to increase respect for it in the future.

— **Service operators and on-board navigation systems**

These operators need to be aware of the measure(s) to integrate them in the pre-trip or real-time services they manage. This implies that road operators make dynamic information available through a relevant interface providing, for instance, real-time DATEX II publications.

Permanent bans may be integrated as restrictions in the navigation systems. Dynamic bans must be disseminated to on-board units through real-time services using DATEX II interfaces.

Organisational requirement:

— **OR3:** Along the same line as OR2 (In the case that road operators have to exchange data requiring interoperability between two or more different organisations, they **must** enable their system to use DATEX II). Services operators **must** be able to integrate the DATEX II publications provided by the road operators when they publish the ban information measure.

4.6.3.5 Common Look & Feel requirements and advice

4.6.3.5.1 Length of the ban section

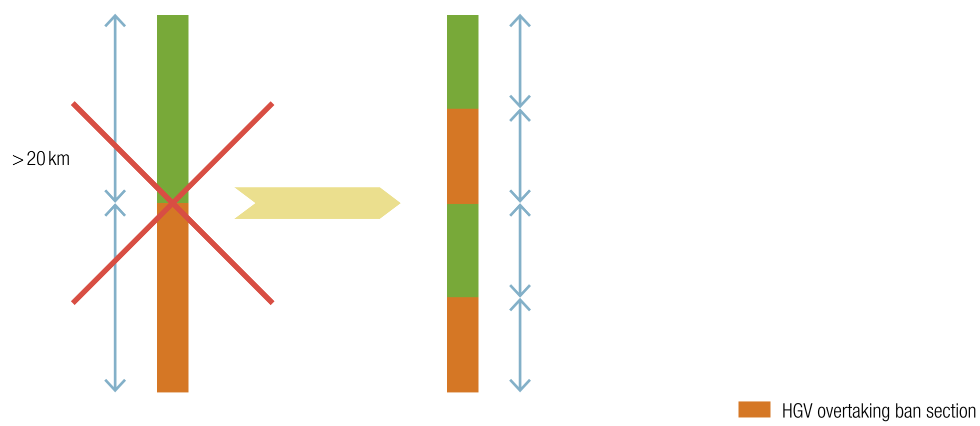
Some evaluation results showed that for a better acceptance of the service, the ban should be implemented on sections from 5 to 20 km long. Above this distance, HGV drivers tend not respect the ban. One observes that it depends on the drivers' cultural approach, which can vary from one country to another. For instance, in Netherlands, the ban is applied on longer sections with a good level of truck drivers acceptance.

Common Look & Feel requirement:

— **CL&FR1:** A wide area deployment of this service **may** limit the length of the ban to 20 km on a section.

The following figure summarises this recommendation:

Figure 76: **Length of ban configuration**



4.6.3.5.2 Beginning of the ban VMS

Common Look & Feel requirement:

— **CL&FR2**: The dynamic HGV overtaking ban **should** require the use of VMS (or prism) display. The icon is the **C, 13ba** panel

Figure 77: **C, 13ba panel**

In the instance that the HGV ban is implemented for specific categories of lorries (> 12 Tonnes for example), in addition to the use of the C 13ba panel (which corresponds to a ban for HGV > 3.5 t.), it is strongly recommended to clearly specify the type of vehicles concerned by the ban.

Common Look & Feel requirement:

CL&FR3: In the case that the HGV ban is implemented for specific categories of lorries (> 12 Tonnes for example), the C 13ba panel **must** be completed with an additional panel type **H,1** which will specify the tonnage of HGV concerned (without tonnage precision the ban applies for HGV > 3.5t)

Example of overtaking ban for HGV > 12 tonnes:

Figure 78: **HGV Ban panel for 12t**

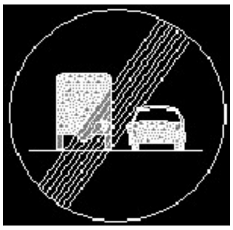
When buses, caravans or vehicles with trailers are concerned by the ban measure the additional panel type H,5 should be used. However, dedicated icons for buses, caravans or trailers need to be studied with ESG4 "Mare Nostrum".

Figure 79: **H5 panel**

4.6.3.5.3 End of the ban VMS

<u>Common Look & Feel requirement:</u>
CL&FR4: The end of the dynamic ban section **must** be signalled, when this end is provided with VMS. The panel to be used is the XC17 d panel:

Figure 80: **C17 d panel**

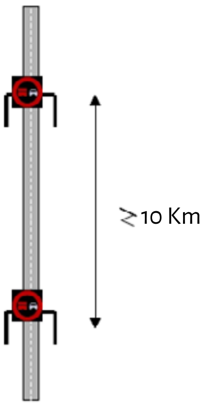


4.6.3.5.4 Location of the signalisation

On the motorway section

<u>Common Look & Feel requirement:</u>
— **CL&FR5:** In order to remind drivers of the dynamic ban when driving, VMS **should** be installed no more than 10km apart.

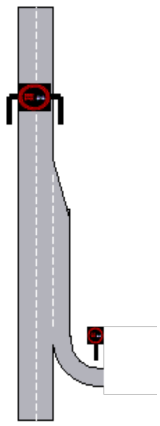
Figure 81: **VMS Configuration A**



At the motorway entrance

<u>Common Look & Feel requirements:</u>
— **CL&FR6:** For the dynamic overtaking ban, a VMS **should** be installed on the motorway section just after the entrance.
— **CL&FR7:** Additional dynamic information using VMS **may** also be installed on the motorway access

Figure 82: **VMS Configuration B**



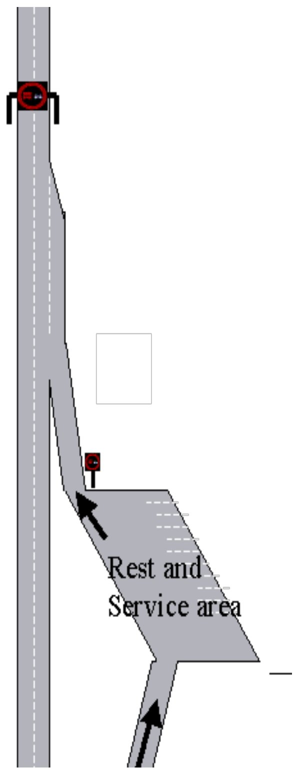
At the exit of rest and service areas

Users stopped on rest and services areas must be informed when restarting their trip. A ban-activation could occur while drivers are taking a rest and they need to be informed when leaving service areas.

Common Look & Feel requirement:

— **CL&FR8:** Additional dynamic information using VMS **may** also be installed at the exit of the rest and service areas.

Figure 83: **VMS Configuration C**



4.6.3.6 ICT Infrastructure requirements

Static overtaking ban deployment does not require specific ITS infrastructure. Deployment of dynamic systems can make use of ICT infrastructures developed for other ITS services. For this dynamic service the required infrastructures are:

Data collection

Technical advice:

— Traffic counting stations

Traffic counting stations constitute the essential data collection entry for the functioning of this traffic management measure. Precision and quality of measures are essential for the ability to react as well as for the response time of the HGV overtaking ban, which has been determined according to flow level or HGV percentage.

Technical requirements:

— **TR1:** the data collection system **may** be able to detect in real-time the following parameters: vehicle flow, speed and HGV%.
— **TR2:** Relevant data input **may** be provided by local detection points on all lanes and/ or by floating car data.
— **TR3:** After the ban area a station to collect journey time information for the evaluation purposes **may** be implemented.

Technical advice:

— Video surveillance

Video surveillance helps traffic managers to assess the measure on vehicles interdistance (implementation of chevron road markings can be used to improve vehicle spacing) and potential difficulties related to the exit of personal vehicles.

— Control system

The system is adapted to the characteristics of the road section as well as to the existing computerised systems and the current equipment. Two solutions are relevant:

- An autonomous analysis system recommended when all equipment systems are dedicated to the measure or in transitory phase for experimentation.
- An integrated solution which is generally better because it offers the possibility to interact with other traffic management measures and equipment.

— Information

It is quite important to widely inform users of the activation of the measure. Two main objectives for the information:

- Acquaint the users with the existence of the measure, with its interest and objectives in order to ensure compliance
- Inform users in real-time through VMS, dedicated road traffic radio, on-board devices, ...

Regarding the timing and area, the following table presents the different potential information means

Table 35: **Possible information means**

LOCATION	VMS (DYNAMIC SERVICE)	FIXED ROAD SIGN	IN VEHICLE (RDS-TMC FOR EXAMPLE)	RADIO	INTERNET
Before departure				X	X
Before the measure area	X	X		X	
In the measure area	X	X	X	X	
In exit area	X	X		X	
At the motorway access	X	X	X	X	

4.6.3.7 Common Look & Feel requirements and advice

Variable message signs requirements:

— **CL&FR9:** The display of signs/pictograms on VMS or other end-user devices **should** be in accordance with prevailing national road codes and:
  - Member States which ratified the Vienna Convention MUST respect the Vienna Convention and the European agreement supplementing the convention (1st May 1971) and SHOULD consider the Consolidated Resolution on Road Signs and Signals (R.E.2).
  - Member States which did not ratify the Vienna Convention SHOULD follow the Vienna Convention and also consider the R.E.2.

Variable message signs advice:

It is recommended that the equipment installed for this service is compatible with the Traffic Control Centre. This compatibility will ensure the interoperability of systems and will allow the possibility to use the dedicated HGV overtaking ban's equipment for another types of traffic management actions if needed.

4.6.3.8 Required standards and specifications

Information provision standards:

— IPS1: If a HGV Overtaking Ban service is implemented at interface 1, the information (see IFR1) **must** be profiled based on EN 161573:2019 using the DATEX II Recommended Service Profile for **HGV overtaking ban**.

— **IPS2**: If interface 2 is implemented, HGV Overtaking Ban information (see IFR2) **must** be profiled using an IVIM based on ISO 19321 using the C-ROADS C-ITS Message Profiles for the In-Vehicle Signage service, specifically the Traffic Sign Use Case.

— **IPS3**: When relevant, the Probe Vehicle Data (microscopic traffic situation) information (see IFR3) **should** be collected, which is profiled based on ETSI EN 302 637-2 using the CAR2CAR Communication Consortium Basic System Profile.

4.6.3.9 Level of Service Definition

4.6.3.9.1 Level of Service Criteria

Table 36 gives the Level of Service recommendations for a HGV Overtaking Ban service. The background of this concept is descripted in chapter 2.6.

Table 36: **Level of Service recommendations for HGV Overtaking Ban**

Levels of Service criteria table: HGV Overtaking Ban			
Core Criteria	**A**	**B**	**C**
Monitoring	Manually on site	Semi-automatic	Automatic through loops, sensors and/or cameras
Overtaking area signing	Fixed (permanent or intermittent service)	VMS (Dynamic service)	VMS (Dynamic service)
Activation and deactivation (decision and action)	Manual	Manual and remote controlled	Manual, based on decision support systems and remote controlled

4.6.3.9.2 Level of Service Criteria related to Operating Environment

Level of Service requirement:

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

Table 37: **Level of Service to Operating Environment mapping table (see also chapter 2.5.3 and ANNEX C)**

HGV OVERTAKING BAN			**Operating Environment**													
Criteria for the Level of Service			C1	T1	T2	T3	T4	R1	R2	R3	R4	S1	S2	N1	N2	P1
Activation and deactivation	C	Manual, based on decision support systems and remote controlled	O			O	O					O	O			
	B	Manual and remote controlled												O	O	O
	A	Manual	M		OM	M	M		OM	OM	OM	M	M	M	M	M
	/	*Service non applicable*		NA				NA	NA*	NA*	NA*					
Overtaking area signing	C	VMS (Dynamic service)										O	O			
	B	Prism or VMS (Dynamic service)	O		O	O	O		O	O	O			O	O	O
	A	Fixed (permanent or intermittent service)	M		M	M	M		M	M	M	M	M	M	M	M
	/	*Service non applicable*		NA				NA	NA*	NA*	NA*					
Monitoring	C	Automatic through loops, sensors and/or cameras										O	O			
	B	Semi automatic	O		O	O	O		O	O	O			O	O	O
	A	Manually on site	M		M	M	M		M	M	M	M	M	M	M	M
	/	*Service non applicable*		NA				NA	NA*	NA*	NA*					

Recommendatons for LoS per OE:

M	Minimum LoS recommended	O	Optimum LoS recommended
		NA	Non applicable
OM	Minimum = Optimum	NA*	Non applicable for two-lane roads

4.7 TMS-06 Incident Warning and Management

4.7.1 ITS service at a glance

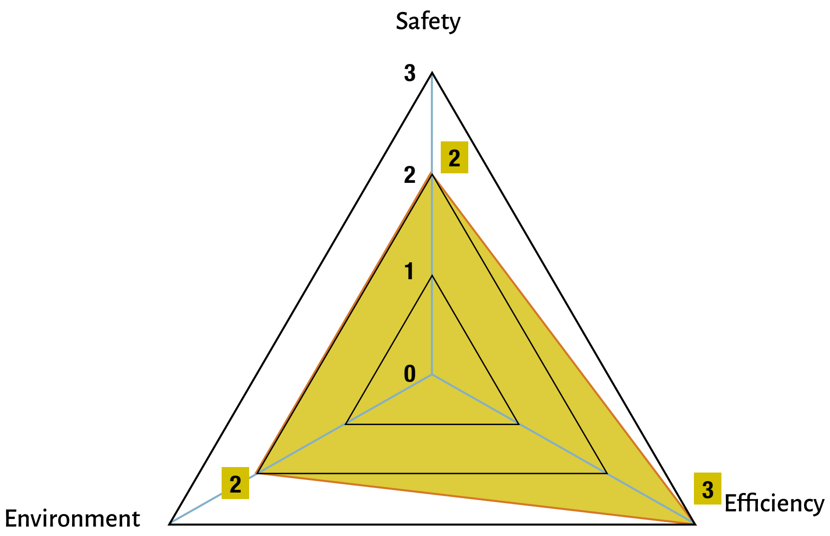
ITS service definition

Incident management (IM) 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.

ITS 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.

ITS service radar



ITS service key words

incident, management, responders, emergency response, accident

4.7.2 ITS service profile

4.7.2.1 General ITS service description

Incident management (IM) 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, mobile or temporary or ad-hoc 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.

4.7.2.2 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.

4.7.2.3 What is the mission?

Three aspects by order of priority:

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.

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.

Control and repair of damage

IM must consider the consequences, including the economic cost incurred, of damage to the vehicles and their 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. 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.

4.7.2.4 Distinctiveness to other ITS services

The ITS service Incident Management and Incident Warning is not comparable to traffic management services as described in the other ITS service descriptions. Together with the ITS service “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 services, in relation to IM, become 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.

4.7.3 Harmonization requirements and advice

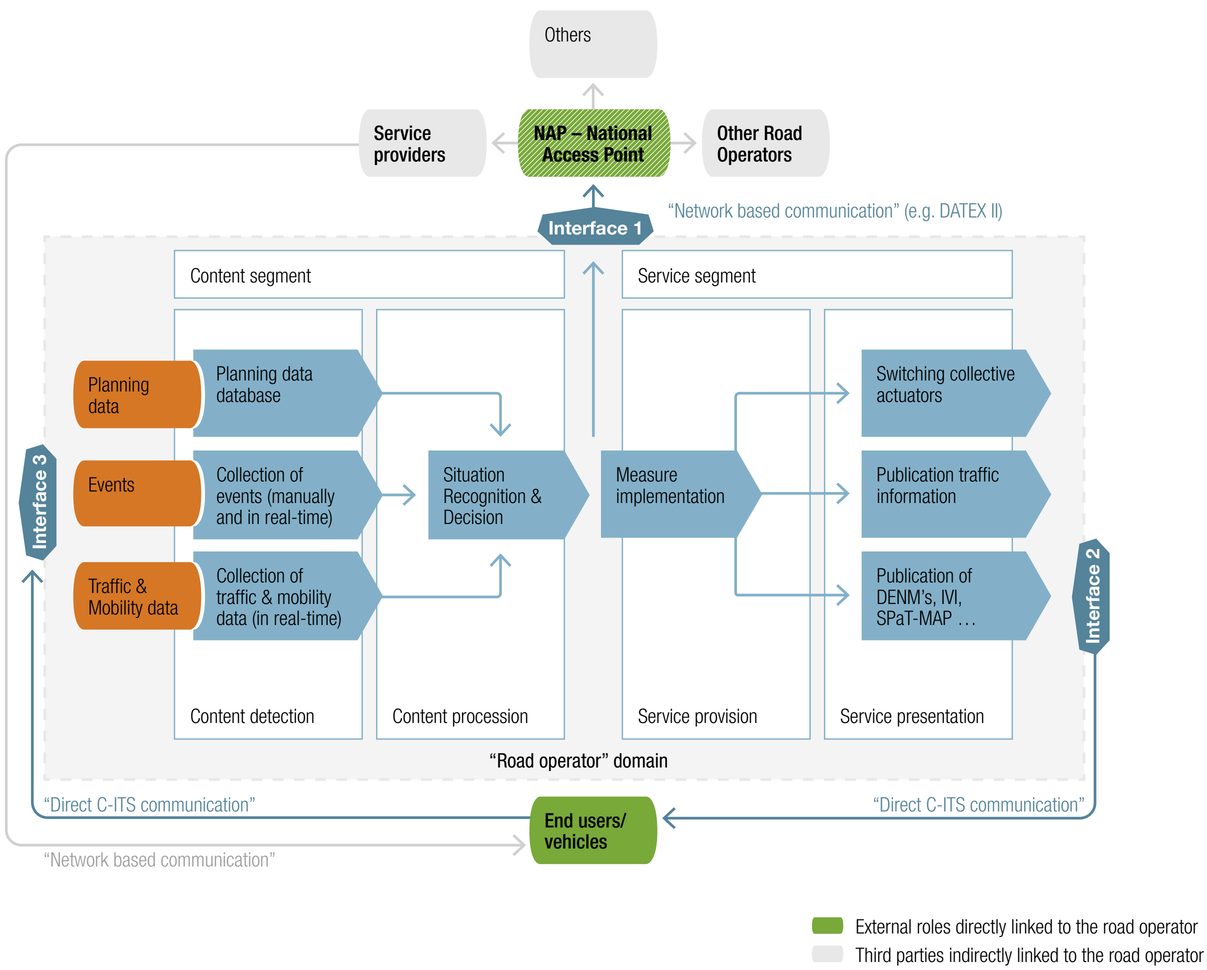
4.7.3.1 ITS service definition

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.

4.7.3.2 Functional Requirements and devices

4.7.3.2.1 Functional architecture

Figure 84: **Functional architecture of Incident Warning and Management service**



4.7.3.2.2 Functional requirements and advice

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.

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 of events or conditions and collection of data: In accordance with Delegated Regulation (EU) No 886/2013 on SRTI, public and private road operators and/or service providers **must** set up or use the means to detect events or identify conditions on the SRTI designated sections of the road network, and **must** distribute the available road safety-related traffic data through a National Access Point. The deployment of these means **must** comply with the conditions and requirements set out in national law.
- **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 **must** be taken to enable IM responders to gain safe access to the incident. To enable restoration to normality the incident scene **must** 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 **should** be warned about the impact of the incident e.g. dynamic road status data (like temporary traffic management measures and road or lane closures) and traffic data (like location and length of traffic queues and travel times).
- **FR8**: Site investigation: investigation **should** 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 **should** be analysed and used to optimize the IM process.

4.7.3.3 Interface requirements

Interface requirements:

- **IFR1**: If the Incident Warning and Management service provides incident warning management information at interface 1 (see Figure 84), it **must** provide coded information including the following elements:
  - Location of the incident
  - Type of incident
  - Actions taken by authorities and road operators to deal with the incident
  - Start time, and, if applicable, the end time of the incident
- **IFR2:** If interface 2 is implemented, the Incident Warning and Management service **must** provide at interface 2 (see Figure 84) Incident Warning and Management information coded in C-ITS messages including the following elements:
  - the respective road sign and text on the road sign (gantry)
  - the location of the accident
  - when relevant, the length and affected lanes of a traffic jam
  - the location of the affected vehicles
  - when relevant, the location of persons on the road
  - when relevant, the location of obstacles (such as car parts) on the road
  - when relevant, the presence of an emergency vehicle
  - when relevant, the presence and location of a blockage of a road (e.g. because of a heavy goods vehicle incident)
- **IFR3:** When relevant, the Incident Warning and Management Service **should** collect at interface 3 (see Figure 84) C-ITS coded Probe Vehicle Data information such as travel speed, direction, current location of a vehicle (microscopic traffic situation) relevant to this ITS Core service.

4.7.3.4 Organisational requirements and advice

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 **should** 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.

4.7.3.5 Common Look & Feel requirements

A common look and feel 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:

ITS-measures

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

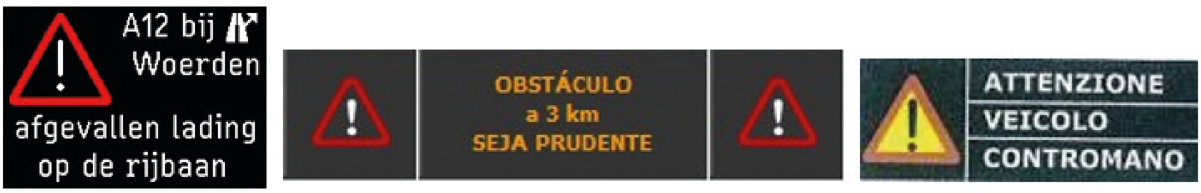
— **CL&FR1**: In dangerous situations at least a danger warning **should** be used as a minimum.
— **CL&FR2**: If VMSs are available, warning signs **should** be used if possible.
— **CL&FR3**: In order to guarantee the harmonization, a danger warning sign **should** be used in accordance with prevailing national road codes and where applicable be in line with International Law (Vienna Convention) and national laws. For example:

Figure 85: **Examples of Danger Warning Signs**

or

— **CL&FR4:** 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 86: **Some examples of incident warning on VMS**



— **CL&FR5:** 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 International Law (Vienna Convention) and national laws. Some examples of this are as follows:

Figure 87: **Examples of Danger Warning Signs with supporting icon**

— **CL&FR6:** The display of signs/pictograms on VMS or other end-user devices **should** be in accordance with prevailing national road codes and:

- Member States which ratified the Vienna Convention MUST respect the Vienna Convention and the European agreement supplementing the convention (1st May 1971) and SHOULD consider the Consolidated Resolution on Road Signs and Signals (R.E.2).
- Member States which did not ratify the Vienna Convention SHOULD follow the Vienna Convention and also consider the R.E.2.

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

Non- ITS measures

— **CL&FR7**: 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 or distance marker post information, ERT - Emergency Road Telephone

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).

Figure 88: **Examples of Driver Location Signs**

4.7.3.6 ICT Infrastructure requirements

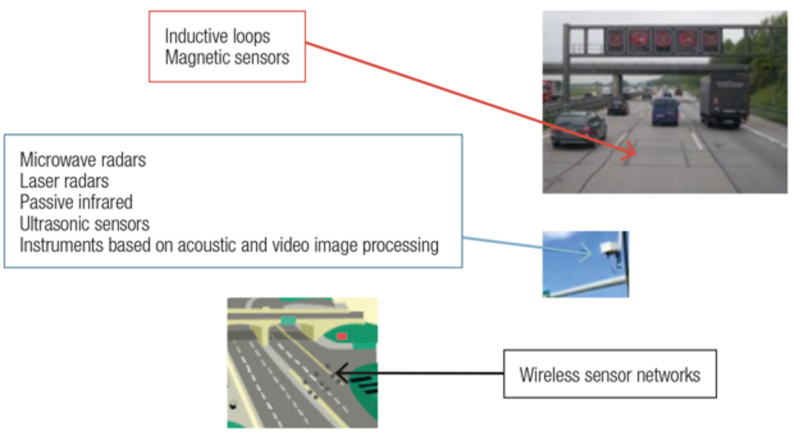
The basis for incident warning, and consequently for its management, is the monitoring of real-time traffic conditions (including weather and road conditions) and the detection of an incident.

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[34]
— 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.

Figure 89: **Traffic monitoring technologies**



It is important to clarify that the technical 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.

34 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.

4.7.3.7 Required standards and specifications

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
— EN 12966-1/2/3:2005. Road vertical signs. Variable message traffic signs.
— Applicable national standards (see the annex)

Information provision standards:

— **IPS1**: If the Incident Warning and Management service provides dynamic road status data and/or traffic data (to road users) at interface 1 (see IPR1), the provision of **must** be compliant to Delegated Regulation (EU) No 2015/962.
— **IPS2**: Information content: In accordance with Article 4 of the Delegated Regulation (EU) No 886/2013, the information provided on the road safety-related events or conditions on SRTI designated sections of the road network **must** include the items listed below. The information shall be withdrawn if the event or condition cease to subsist or shall be modified if there is a change in the event or condition.
  - Location of the event or the condition
  - The category of event or condition as referred to in Article 3 of the SRTI Delegated Regulation and, where appropriate, a short description of it
  - Driving behaviour advice, where appropriate.
— **IPS3**: Availability, exchange and reuse of data: Public and/or private road operators and/or service providers **must** share and exchange the data they collect on SRTI designated sections of the road network pursuant to Article 6 of the Delegated Regulation (EU) No 886/2013, or Functional Requirement 2, in compliance with Article 7 of the Delegated Regulation (EU) No 886/2013.
— **IPS4**: Dissemination of Information: In accordance with Article 8 of the Delegated Regulation (EU) No 886/2013, public road operators, service providers and broadcasters dedicated to traffic information **must** provide road safety-related minimum universal traffic information of SRTI designated sections of the road network to end users prior to the provision of any other non-safety-related traffic information. The information service **must** be compliant with Delegated Regulation (EU) No 886/2013 Article 8.
— **IPS5**: If interface 2 is implemented, Incident Warning and Management information regarding the in-vehicle signage of road signs (see IFR2) **should** be profiled in an IVIM (Infrastructure to Vehicle Information Message) based on ISO 19321 using the C-ROADS C-ITS Message Profiles for the In-Vehicle Signage service. Additionally, all other Incident Warning and Management information (see IFR2) should be profiled in a DENM (Decentralized Environmental Notification Message) based on ETSI EN 302 637-2 using the C-ROADS C-ITS Message Profiles for the DEN Basic service.
— **IPS6**: When relevant, the Probe Vehicle Data (microscopic traffic situation) information (see IFR3) **should** be profiled based on ETSI EN 302 637-2 using the CAR 2 CAR Communication Consortium Basic System Profile.

4.7.3.8 Level of Service Definition

4.7.3.8.1 Level of Service Criteria

Table 38 gives the Level of Service recommendations for an Incident Warning and Management service. The background of this concept is descripted in chapter 2.6.

Table 38: **Level of Service recommendation for Incident Warning and Management**

<table>
<tr><th colspan="5">Levels of Service criteria table: Incident Warning and Management</th></tr>
<tr><th colspan="2">Core Criteria</th><th>A</th><th>B</th><th>C</th></tr>
<tr><td colspan="2">RESPONSE TIMES</td><td>Informal
No formalized Service Level Agreements on response times (example: formal agreement to arrive at the incident scene within 30 minutes.)</td><td>Individual
Every IM partner has its own independent Service Level Agreements.</td><td>Coordinated
The Service Level Agreements are coordinated to limit the time to resolve an incident.</td></tr>
<tr><td rowspan="3">INFORMATION QUALITY</td><td>FREQUENCY
of information service
(with VMS, media, navigation systems, etc.)</td><td>Messages are updated every hour</td><td>Messages are updated every 30 minutes</td><td>Messages are in real-time (updated at least every 5 minutes)</td></tr>
<tr><td>CONTENT
of the information</td><td>Information about the kind of alert and location (e.g. incident on A4)</td><td>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)</td><td>Information is customized according to the position of user (e.g. navigation systems could give several diversion options)</td></tr>
<tr><td>RELAY TIME
of the information (from the detection of the incident)</td><td>Information within 1 hour</td><td>Information within 30 minutes</td><td>Real time information (max. 5 minutes delay)</td></tr>
<tr><td colspan="2">SAFETY OF THE ROAD USER
recognisability of the incident scene and of IM-partners; protection of the incident scene</td><td>Recognisability of vehicles 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</td><td>Vehicles 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</td><td>Vehicles 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</td></tr>
</table>

4.7.3.8.2 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.

Table 39: **Level of Service to Operating Environment mapping table (see also chapter 2.5.3 and ANNEX C)**

INCIDENT MANAGEMENT			Operating Environment													
Criteria for the Level of Service			C1	T1	T2	T3	T4	R1	R2	R3	R4	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	M	M	M	M	O
	A	Informal		M	M	M	M	M	M	M	M					M
Information quality FREQUENCY of infor-mation service(with VMS, media, navigation systems, etc.)	C	Messages are in real times (updates 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	M	M	M	M	O
	A	Messages are updated every 3hour		M	M	M	M	M	M	M	M					M
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	M	M	M	M	O
	A	kind of alert and location		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	M	M	M	M	O
	A	Information within 1 hour		M	M	M	M	M	M	M	M					M
Safety of the road user: recogniza-bility of the incident scene and of IM partner. Protection of the incident	C	All equipment recognizable, all wear safety jacket, IM scene is fully protected.	O									O	O	O	O	
	B	All equipment recognizable, all wear safety jacket, IM scene is protected, but not fully	M	O	O	O	O	O	O	O	O	M	M	M	M	O
	A	Recognizability not coordinate, all wear safety jackets and IM scene is indicate, but open.		M	M	M	M	M	M	M	M					M

Recommendatons for LoS per OE:				
	M	Minimum LoS recommended	O	Optimum LoS recommended
	OM	Minimum = Optimum	NA	Non relevant

4.8 TMS-07 Traffic Management for Corridors and Networks

4.8.1 ITS service at a glance

ITS Service definition

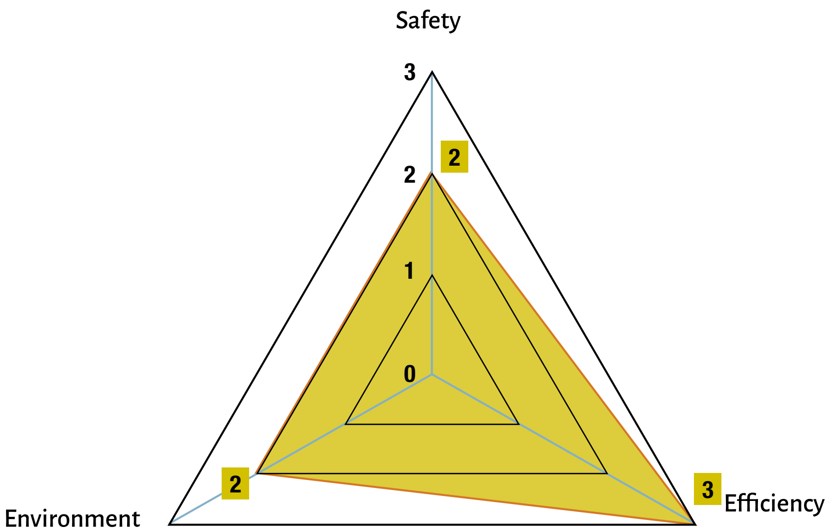
"Traffic Management Plan for Corridors and Networks" means the elaboration, application and quality control of Traffic Management Plans (TMP) for the management of the European network and corridors including multi-modal capacities to allow for a more efficient use of the road network in Europe (and not restricting measures to country or local basis).
A TMP is the pre-defined allocation of a set of measures to a specific situation in order to control and guide traffic flows as well as to inform road-users in real-time and provide a consistent and timely service to the road user. Initial situations can be unforeseeable (incidents, accidents) or predictable (recurrent or non-recurrent events). The measures are always applied on a temporary basis.
Four spatial levels are suited to the elaboration of such complex TMPs:

— **Regional TMPs**: for networks within areas or regions on the TEN-T that can be extended, under certain conditions, to link with neighbouring regions for cross-regional and cross-border levels.
— **Cross-regional TMPs**: for national networks and key corridors on the TEN-T covering multiple regions
— **Cross-border TMPs**: for cross-border networks and key corridors on the TEN-T and
— **TMPs for conurbations**: conurbations and the urban/inter-urban expressways network with relevance to long-distance traffic.

ITS Service objective

The vision of the European Core Service "Traffic Management Plan for Corridors and Networks" is the effective delivery of traffic control, route guidance and information measures to the road user in a consistent manner, thus increasing the performance of transport infrastructure by adding the potential of cross-border, network or multi-stakeholder co-operation, when needed. Through strengthening the cooperation and the mutual understanding of road operators in conurbations and on the cross-national/international level the provision of a co-ordinated approach for elaboration, application and quality control of traffic management measures will be achieved. Properly developed multiple level TMPs react to various traffic situations in a timely and effective manner. They optimise the use of existing traffic infrastructure capacities and provide the platform for a cross-border seamless service with consistent information for the road user.

ITS service radar



ITS service key words

Traffic Management Plan, re-routing, Regional TMP, Cross-regional TMP, Cross-border TMPs, TMP MPs for conurbations, Situation - incidents and/or events which require the application of a TMP, Scenario, Response, Strategy, Measure, Action

4.8.2 ITS service profile

4.8.2.1 General ITS service description

"Traffic Management for Corridors and Networks" means the elaboration, application and quality control of Traffic Management Plans (TMPs) for the management of the European network and corridors including cross-regional, cross-border and multi-modal aspects.

A TMP is the pre-defined allocation of a set of measures to a specific situation in order to control and guide traffic flows as well as to inform road-users in real-time and provide a consistent and timely service. Initial situations can be unforeseeable (incidents, accidents) or predictable (recurrent or non-recurrent events). The measures are always applied on a temporary basis. TMPs can be based on the full range of feasible traffic control, route guidance and traveller information measures, not only depending on the initial situation but also on available facilities (see also 4.8.3.3).

Deployment of TMPs ensures a higher level of service in terms of increased traffic efficiency on the network and improved safety in terms of incident response and mitigation through a consistent and effective delivery of traffic control, route guidance and information measures to the road user.

4.8.2.2 What is the vision?

The vision of the European ITS Core Service "Traffic Management for Corridors and Networks" is the effective delivery of traffic control, route guidance and information measures to the road user in a consistent manner, thus increasing the performance of transport infrastructure by adding the potential of cross-border, network or multi-stakeholder/cross-competence co-operation, when needed. Through strengthening the cooperation and the mutual understanding of road operators in conurbations and on the cross-national/international level the provision of a co-ordinated approach for elaboration, application and quality control of traffic management measures will be achieved.

Properly developed multiple level TMPs react to various traffic situations in a timely and effective manner. They optimise the use of existing traffic infrastructure capacities and provide the platform for a cross-border seamless service with consistent information for the road user.

The visions on behalf of the road user are:

- to provide seamless, language independent and consistent cross-border and traffic management and traveller information,
- to consider the network as a whole to optimise the use of existing traffic infrastructure capacities and
- to permanently enhance the quality of service provided by the traffic management service.

The visions on behalf of the road operators are:

- to come to a harmonised understanding as well as a co-ordinated, consistent deployment and application of traffic management measures on an operational level in locations where various stakeholders such as road operators and traffic police share traffic management responsibilities,

— to strengthen the cooperation and the mutual understanding of road operators in conurbations and on cross-national/ international levels,
— to exchange know-how and experience in developing tools for the development and testing of traffic management plans between the stakeholders on a European level and
— to establish co-operation not only between public road operators but also with private service providers using in-car facilities to disseminate public traffic management plans, so that they align their traffic behaviour with the overarching strategies of public road operators (see Traffic Management 2.0[35]).

4.8.2.3 What is the mission?

Cross-border/cross-competence deployment

— Different political, legal, technical and organisational basic conditions, language (even dialects) and cultural differences of partners:
→ Take into account the individual backgrounds and requirements of each partner; determine a common understanding in a LoI (Letter of Intent) or a MoU (Memorandum of Understanding).
→ In advance of pre-defining TMPs, all partners have to have a clear understanding of each other's needs and requirements.
→ Define a common harmonised glossary and map in advance.
— Different responsibilities inside the organisational structure of each partner:
→ Define a "single entry point" on the operational level. Avoid escalating every single operational problem to the management level.
— In most countries, broadcasting companies cannot be forced to broadcast specific traveller information or re-routing recommendations, which leads to inconsistent information:
→ Involve broadcasters and other service providers from the start and foster a good relationship with them. In some cases, broadcasting companies share databases or have their operators in the TCC.
— Possible problems of language and/or interpretation by the road user:
→ Communication to the road user as far as possible through clear and mono-interpretable pictorial signs. Use of language only as explanation for the signs used.

Re-routing TMPs:

— Insufficient capacity on the alternative routes or road operators affected by the re-routing are not willing to accept re-routing on routes or secondary roads with limited capacity and/or excessive traffic-related environmental impact:
→ Intense advance planning and coordination processes between the various authorities involved and co-ordinated TMP activation process on the basis of mutual confidence in event assessment and activation requests is necessary.
→ A common pre-definition of prioritization between the impacted partners is necessary and agreements on how to prioritize traffic management measures to handle various incident types.
→ Other measures such as information, vehicle storage areas, modal shift or access control should be considered.
— The cost of tolls to the road user has a considerable influence in their route selection.
→ The decision criteria "price" has to be considered and eventually communicated.
— Inconsistent service content between publicly financed road operators and private service providers. The prompt deactivation of a measure in case of an incident cancellation through private service providers seems to be a problem.
→ Involve private service providers in the TMP elaboration process and develop framework

35 https://tm20.org/

agreements between public financed road operators and service providers to share information (see Traffic Management 2.0).

Multimodality

— Insufficient consideration of public transport and rail capacities in traffic management
→ TMPs should consider the utilisation of alternative modes of transport when capacities are available (see TTIS-DG05: Multimodal Travel Information services).

Evaluation

— Knowledge about drivers' behaviour is still quite limited
→ Experiences gained from statistical data and monitoring of TMP impacts should be analysed regularly.

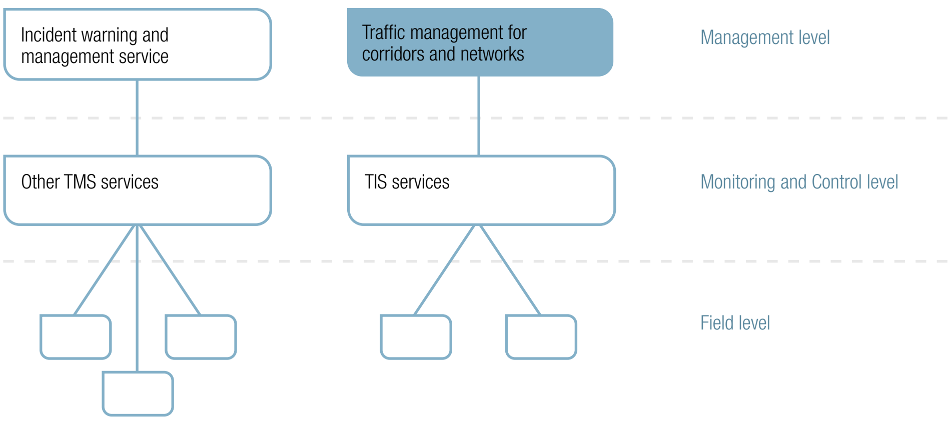
Human resources

— The human resources required are hard to estimate, because TMPs often work "on top" of existing measures. With the implementation of a TMP service the work can get more complex for the operator. Normally, organisations are currently not able to provide such a service with the human capacities available to them.
→ Allocation of motivated and well-trained - if necessary additional - staff is essential and often crucial to the success of the service.

4.8.2.4 Distinctiveness to other ITS services

"Traffic Management for Corridors and Networks" is not comparable to other traffic management services described in this handbook. Together with the "TMS-06 Incident Warning and Management service" (see 4.7) it is by its very nature a service that is allocated at the management level which - based on an overarching network strategy - uses and applies other services located on the monitoring and control level with a more local impact. The principle is shown in the Figure 90:

Figure 90: **Allocation of Traffic management for Corridors and Networks in contrast to other ITS-services**



4.8.3 Harmonization requirements and advice

4.8.3.1 ITS service definition

“Traffic Management for Corridors and Networks” means the elaboration, application and quality control of Traffic Management Plans (TMP) for the management of the European network and corridors including multi-modal capacities to allow a more efficient use of the road network in Europe (and not restricting measures to country or local basis).

A TMP is the pre-defined allocation of a set of measures to a specific situation in order to control and guide traffic flows as well as to inform road-users in real-time and provide a consistent and timely service to the road user. Initial situations can be unforeseeable (incidents, accidents) or predictable (recurrent or non-recurrent events). The measures are always applied on a temporary basis.

4.8.3.2 Initial Situations

Initial situations for the application of the Traffic Management for Corridors and Networks service are incidents or/and events that negatively affect traffic flow, traffic safety or environment. In the following the situations are listed:

- accidents, road works, adverse weather conditions (thick fog, heavy snow, glace, floods), natural disasters (earthquakes, landslides, overflows)
- strikes, demonstrations,
- major public events, sport events
- exceeding air pollution
- emergencies (such as evacuations of public events, evacuation of ports of airports, closures of tunnels)
- holiday traffic peaks, capacity overload on the road network or of public transport.

A main aspect of incidents is the location, duration and capacity reduction of the incident. A consistent definition of these parameters is essential for effective information and intervention.

4.8.3.3 Types of TMPs

4.8.3.3.1 Overview

Four spatial levels are suited to the elaboration of such complex TMPs:

- **Regional TMPs:** for networks within areas or regions on the TENT-T that can be extended, under certain conditions, to link with neighbouring regions for cross-regional and cross-border levels.
- **Cross-regional TMPs:** for national networks and key corridors on the TENT-T, covering multiple regions
- **Cross-border TMPs:** for cross-border networks and key corridors on the TENT-T and
- **TMPs for conurbations:** conurbations and the urban/inter-urban expressways network with relevance to long-distance traffic.

4.8.3.3.2 Long-distance TMPs

A pre-defined and co-ordinated strategic traffic management is a proven concept applied all over Europe, in particular on routes with specific complex demands. The most common initial situations are winter problems, a generally high traffic volume, long-lasting road works, emergencies, typical main routes of holiday traffic, cross-border traffic, a close interrelation between long-distance and regional traffic in conurbations, air pollution problems in conurbation areas.

The initial situations are as manifold as the traffic management measures applied:
- In the North-West of Europe re-routing and traveller information measures outweigh. The reason for it is the dense highway network in this area combined with a high traffic volume in relatively small states. Besides, various alternative sea crossing possibilities (such as bridges, tunnels, ferries) require re-routing TMPs in case of bad weather conditions or strikes.
- In some areas as the Alpine regions, re-routing possibilities are limited due to capacity and environment problems on alternative routes and secondary networks. They are only activated in case of extreme incidents as long duration closures requiring regional and cross-border intervention. The issue is to rapidly respond and manage the incident on a local level before it propagates to a major size requiring significant re-routing measures.
- In South Europe, other main aspects are emergencies and weather problems (snow, floods, etc). Here HGV (storage, driving ban, overtaking ban) play a key role (besides re-routing of cross-border traffic).

Great diversity is also seen in organisational and technical aspects. Whereas France has a more or less centralised organisational structure with one entity for the TMP, other countries as Germany are organised on a federal level, all partners are equal in their rights and responsibilities. This decentralised approach is also applied in case of cross-border TMPs.

Different carriers and financing concepts for highways (public, private) have strong impact on investments in technical equipment on highways as well as possibilities and reservations concerning TMPs. In some areas, re-routing involves more than one road operator on the corridor, with traffic police solely responsible for closure and opening of motorways.

Some national guidelines for traffic management exist. They describe the entire process of traffic management, from the initial intent to improve a local traffic situation right up to an integrated traffic management concept. Some of them focus on the evaluation of TMPs. They are applied on a national, regional and local level resulting in a highly structured and user oriented approach of traffic management.

All the named aspects should be harmonised step-by-step on European level. Not with the aim to define one overall valid technical and organisational approach, but with the aim to simplify the connection of existing TMPs along corridors and/or within neighbouring regions, to transfer experiences and to avoid double development work and conflicting strategies.

Objectives for future work on European level concerning TMPs are:
- A stronger link-up of national or regional TMPs and establishing new international TMPs.
- To assist new member states in Eastern Europe establishing appropriate TMPs.
- To strengthen the cooperation between “old” and ‘‘new’’ Member States in order to harmonise strategies and establish cross-border TMPs, when needed, between the various regions in Eastern and Western Europe.
- To harmonise international TMP- and system-approaches and structures on a European level.
- To implement a denser network of ITS systems to enhance the efficiency of TMP (VMS, traffic information services, parking areas, etc.).

4.8.3.3.3 TMPs in conurbation areas

TMPs for conurbations are in many regions a relatively different field of work with a different scope of measures ranging from traffic signals, parking, and interurban rerouting to public transport measures in addition to interaction with motorways. First of all they are initiated in case of pre-planned events (sports events etc., or road works) but also unplanned events or recurrent congestion caused by commuter traffic, but also due to air pollution or due to the strong impairment of the conurbation area brought by the long-distance and urban traffic.

There is a need to address the interface between the TEN-T and local feeder and distributor roads in urban areas. Since the quality of traffic flow on the TEN-T can impact and be impacted by the surrounding urban environment, comprehensive TMP's are required between the relevant urban road and motorway organisations. A number of regions have already the organisation and the technical mechanisms for such a process.

4.8.3.3.4 TMPs for freight transportation

The stakeholders of freight transportation differ completely from those of the strategic traffic management on the European road network and thus the influence of road organisations on this aspect is limited. In the long term they can be influenced through political decisions.

However, four aspects of freight transport belong to the context of Traffic Management Plans, because they affect the road network strongly. They are applied temporarily and they are part of public responsibilities:
— Dynamic ban of driving for HGV / dynamic overtaking ban for HGV
— Dynamic access control for HGV (in the context of passage through sensitive or limited capacity areas as tunnels and mountain passes)
— Dynamic access control for HGV (in the context of air pollution) and
— Temporary HGV storage areas (e.g. temporary hard shoulder usage for HGV storage)

4.8.3.3.5 Multimodality

TMPs have a multimodality aspect if applied measures include actions with the aim of modal shifting of traffic.

— On the cross-border level by multimodality (between road, rail, sea, waterways, air) currently affects only freight transportation (HGV transportation). Measures are applied permanently in order to optimise existing infrastructure capacities or temporarily in case of an incident (TMP).
— In conurbations, the main aspect of multimodality is the combination of road and public transport for individual traffic in case of a predictable or long-lasting incident.
— As in road TMPs, the forecast reliability of the incident is an important element for multimodal TMP elaborations. For predictable incidents, such as congestion due to commuter traffic or fairs, multimodal TMPs can be developed. Spontaneous modal shifting on a large scale, particularly in conurbations, often fails because of lacking capacities of the public transport.

Nevertheless, the increasing traffic demand and the increasing interrelation of transport modes require a very close cooperation between the stakeholders of different transport modes.

4.8.3.4 Functional requirements and advice

4.8.3.4.1 Overview

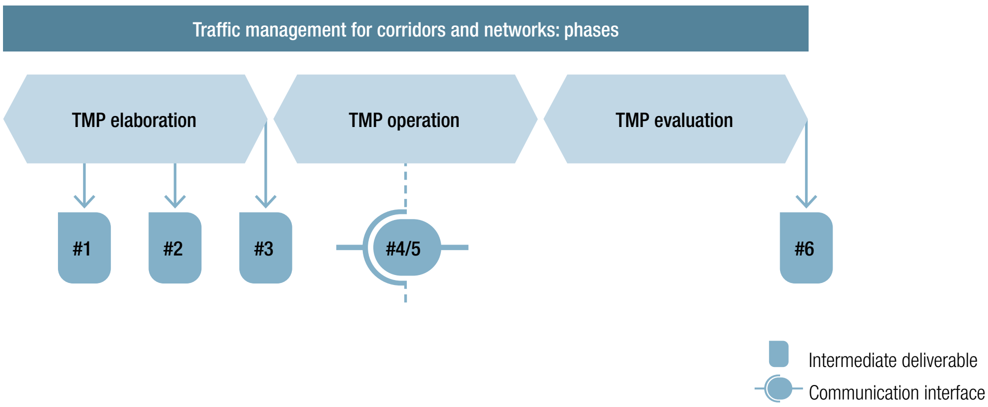
The entire functionality of Traffic Management for Corridors and Networks service can be divided into three different phases which by their nature strongly differ:

- **TMP elaboration phase:** Generally, the service is a common management task of various organisations involved, not only in combining other different TMS and TIS services, but also with the effects on networks of different authorities. Hence a thorough preparation of the service and documentation by means of intermediate deliverables is a MUST to create and agree upon a clear common understanding between all stakeholders involved
- **TMP operation phase**: This is the phase where the actual service is provided to the end user
- **TMP evaluation phase**: Generally, traffic and traffic conditions change rapidly, particularly if end users change their behaviour when confronted with traffic management measures. Hence a thorough analysis of the service impacts and – if necessary - revision of the service organisation is also a MUST and should be undertaken recurrently. The evaluation results must be documented and, in-turn, provide input for improving the service.

Setting up a service Traffic Management for Corridors and Networks normally leads to high costs, not only in the elaboration phase but most importantly regarding operation and evaluation, which are recurrent costs. To prevent incorrect decisions, particularly in the elaboration phase, different process steps must be run through and each concluded with resulting documentation as an intermediate deliverable which then provides decision possibilities for the next step.

The phase concept of the service is depicted in Figure 91:

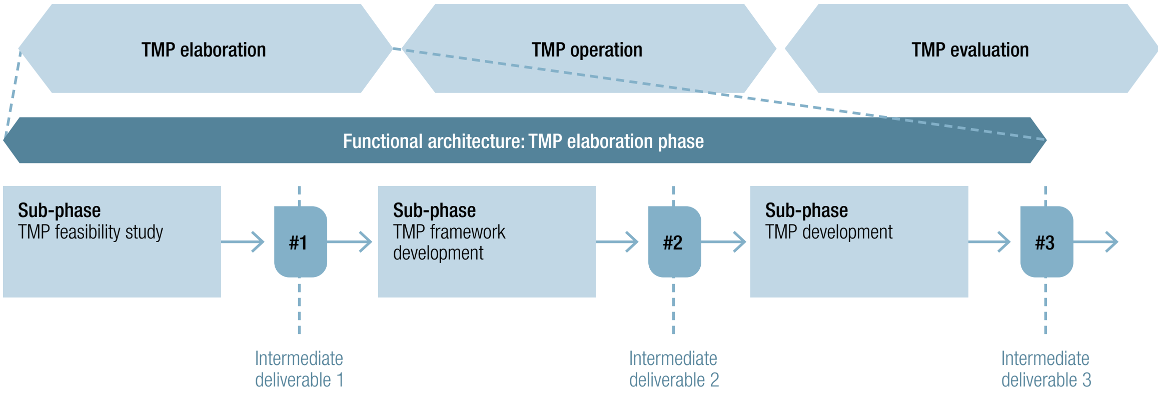
Figure 91: **Traffic Management for Corridors and Networks – phase concept**



4.8.3.4.2 TMP elaboration phase

Figure 91 shows the functional architecture of the Traffic Management for Corridors and Networks service in the elaboration phase as a generic approach. This model is used to identify where it is appropriate to segment the whole functionality of the service into sub-phases and to provide intermediate deliverables to create and ensure a common understanding between the different parties involved.

Figure 92: **Functional architecture: TMP elaboration phase**

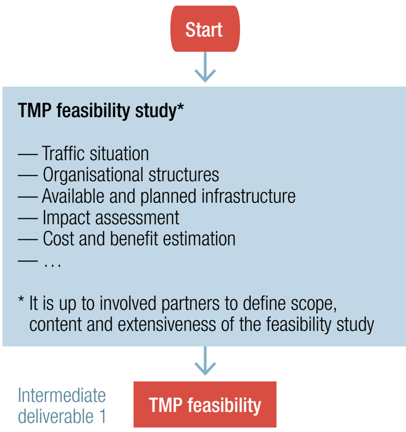


Functional requirement:

— **FR1**: Decomposition of the TMP elaboration phase into sub-phases (process steps) with the provision of intermediate deliverables **must** be carried out in those cases where the service is carried out by two or more (not closely related) organisations (and decomposition is recommended in any case to be prepared to involve yet further parties as may be the case in the future).

Sub-phase 1 "TMP feasibility study"

Figure 93: **Functional architecture: sub-phase "TMP feasibility study"**

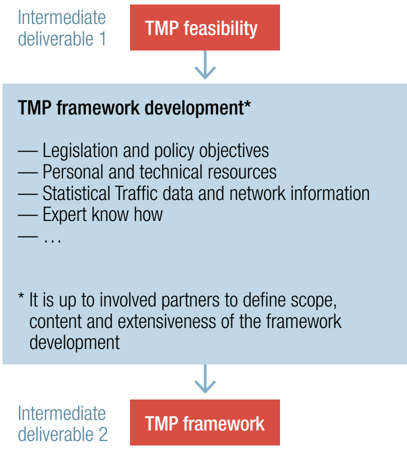


Functional requirement:

— **FR2**: A TMP feasibility study or cost/benefit analysis **must** be processed and a TMP feasibility document as intermediate deliverable 1 **must** be delivered as input for the next sub-phase (TMP framework development).

Sub-phase 2 "TMP framework development"

Figure 94: **Functional architecture: sub-phase "TMP framework development"**



Functional requirement:

— **FR3:** Based on the input of sub-phase TMP feasibility document (intermediate deliverable 1) a sub-phase TMP framework development **must** be processed and a TMP framework document as intermediate deliverable 2 **must** be delivered as input for the next sub-phase (TMP development).

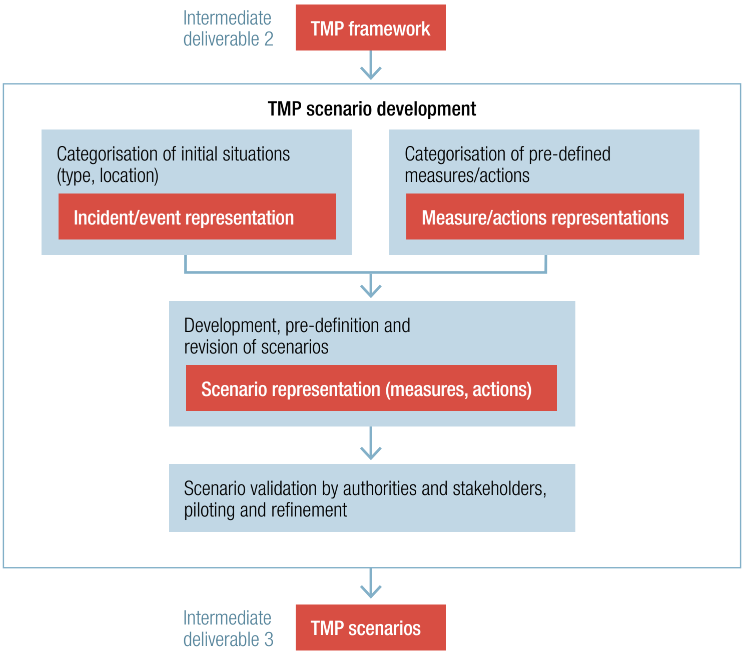
Sub-phase 3 "TMP development"

Note: Concerning the information structure of TMPs different wordings exist in Europe. For the purpose of unambiguous understanding, only the following wording conform to CEN/TS 16157-8:2019[36] is used:

— **Situation** - incidents and/or events which require the application of a TMP
— **Scenario** - an initial situation caused by unforeseeable incidents/accidents or predictable recurrent or non-recurrent events in combination with a specific response
— **Response** - a strategy or a single measure to respond to the impact of the initial situation
— **Strategy** - set of measures appropriate to respond to the impact of the initial situation
— **Measure** - a possible set of actions to respond to the impact of the initial situation
— **Action** - one measure can consist of various actions to respond to the impact of the initial situation

36 (Intelligent transport systems - DATEX II data exchange specifications for traffic management and information - Part 8: Traffic management publications and extensions dedicated to the urban environment, „TmplanTAblePublication" class model)

Figure 95: **Functional architecture: sub-phase “TMP development”**



Note: in Europe, different methods for detection, verification and reporting of incidents are used. These methods are not covered by this Reference Handbook.

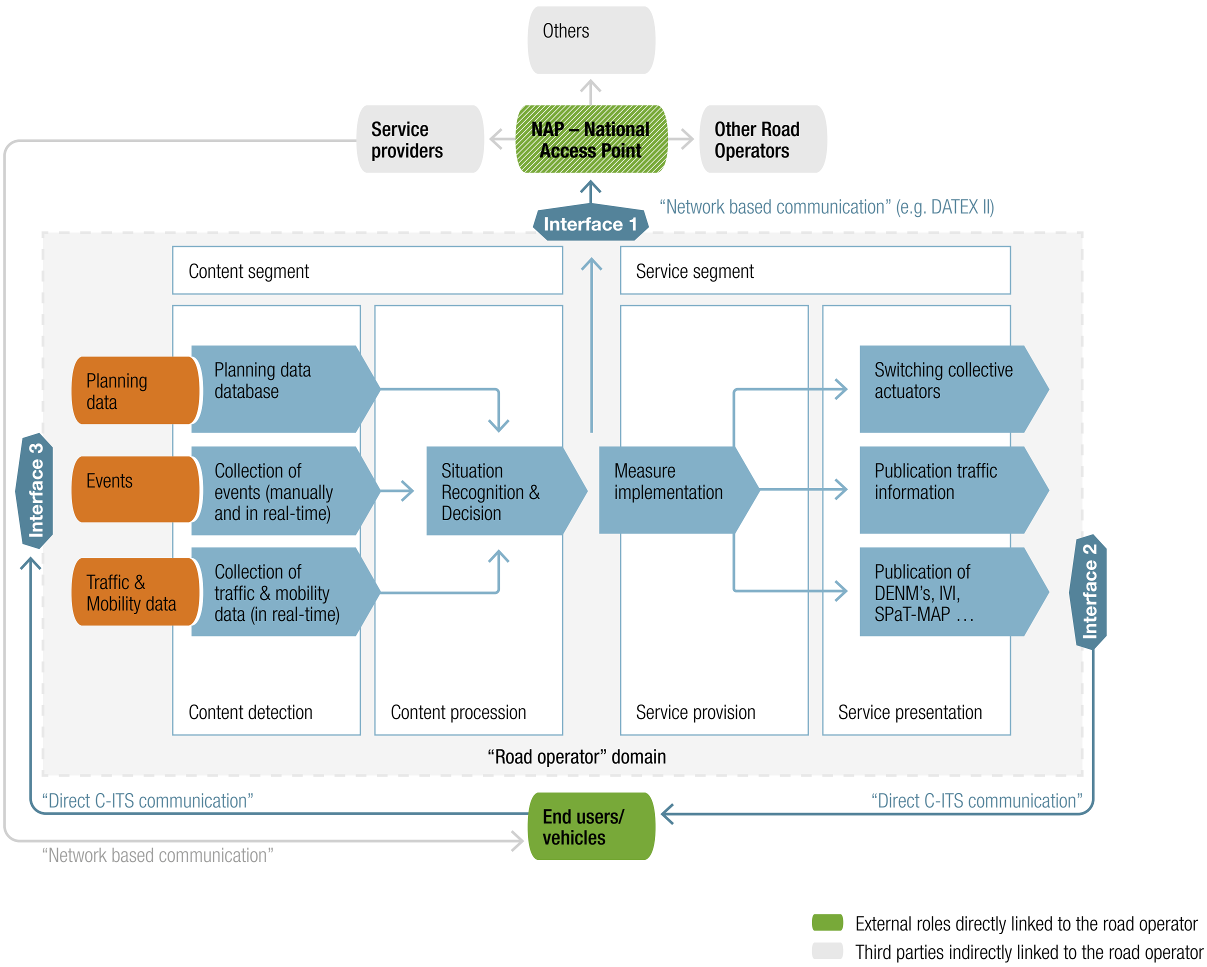
Functional requirement:

FR4: Based on the input of sub-phase TMP framework development (intermediate deliverable 2) a sub-phase TMP scenario development **must** be processed and a “TMP scenarios publication” as intermediate deliverable 3 **must** be delivered as input for the next phase (TMP operation).

4.8.3.4.3 TMP operation phase

Figure 96 shows the typical functional architecture of the Traffic Management for Corridors and Networks service in the operation phase.

Figure 96: **Functional architecture: TMP operation phase**

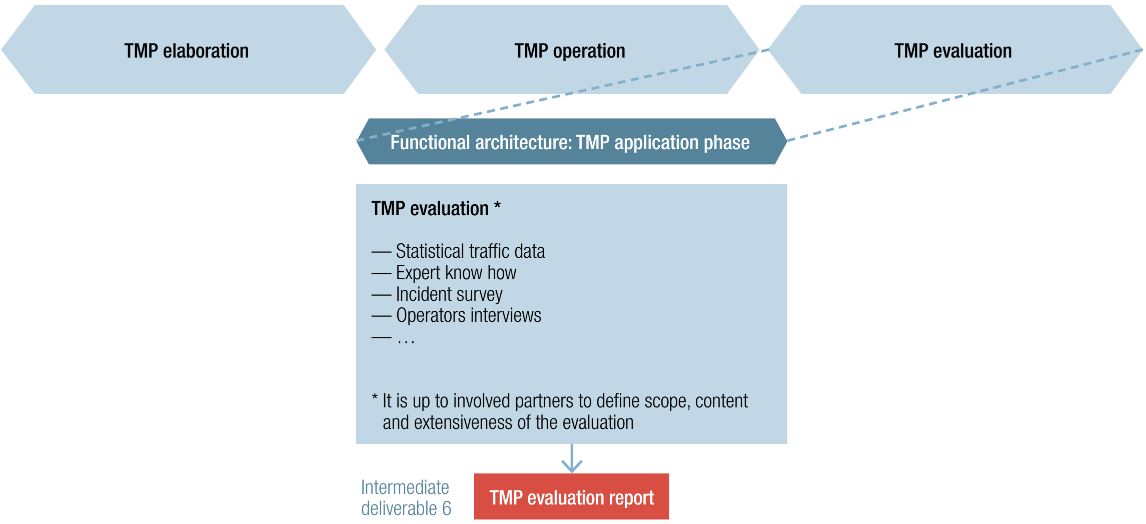


Functional requirement:

- **FR5**: Functional decomposition of the TMP operation phase into sub-functions with the provision of interfaces **must** be carried out to ensure interoperability in those cases where the service is carried out by two or more (not closely related) organisations (and functional decomposition is recommended in any case to be prepared to involve yet further parties as may be the case in the future).
- **FR6:** For the purpose of information exchange between partners and bodies involved in TMP-service a "TMP operation publication" **must** be generated and published showing the scenario which was selected corresponding to an initial situation and the current status of operation.

4.8.3.4.4 TMP Evaluation phase

Figure 97: **Functional architecture of "TMP evaluation"**



Functional requirements:

- **FR7:** Important and frequently applied TMPs **must** be assessed and preferably periodically adjusted and a TMP evaluation document as intermediate deliverable 6 **must** be delivered as input for a possible necessary improvement of the TMP operation. Hence an evaluation model and an evaluation process **must** be defined.
- **FR8:** The TMP evaluation process **should** compile various sources of information like:
  - Statistical traffic data
  - Experiences of road authorities and operators
  - Survey of incidents with Scenarios (and measures) activated
  - Interviews and questionnaires with operators and road users
  - ...

4.8.3.5 Interface requirements

Interface requirements:

- **IFR1a**: A Traffic Management for Corridors and Networks service **must** provide coded "TMP scenario information" at interface 1 (see Figure 96), including the following elements:
  - The details of proposed traffic management plans, including the scenario for which they are applicable, and the definition of measures and actions that shall be taken as part of the traffic management plan
- **IFR1b:** A Traffic Management for Corridors and Networks service **must** provide coded "TMP in operation information" at interface 1 (see Figure 96), including the following elements:
  - Status information and status change information relating to elements of a traffic management plan. The information may relate to a previously defined traffic management plan or a traffic management plan that has not previously been defined.
- **IFR2**: If interface 2 is implemented, the Traffic Management for Corridors and Networks service **must** provide at interface 2 (see Figure 96) Traffic Management information coded in C-ITS messages including the following elements:
  - the information and setting of the sign

— **IFR3:** When relevant, the Traffic Management for Corridors and Networks service **should** collect at interface 3 (see Figure 96) C-ITS coded Probe Vehicle Data information such as travel speed, direction, current location of a vehicle (microscopic traffic situation) relevant to this ITS Core service.

4.8.3.6 Organisational Requirements

4.8.3.6.1 Stakeholder roles to respect and to involve

Organisational requirement:

— **OR1:** All different stakeholder roles needed to be involved in the three phases of the service **must** be considered and defined (role concept)

Typical TMP-stakeholders-roles are:

— Primary Stakeholders (motorway TMPs)
  - **Road Operators**: public/private road organisations and companies in charge of management of road links and networks
  - **Service Providers**: broadcasting companies, public and private traveller information service providers, navigation service providers
  - **Enforcement**: national and regional traffic police
  - **Emergency Services**: fire and emergency services
  - **Border authorities:** customs and border guard
  - **National and Regional Organisations**: Ministries and regional administrations (e.g. ministry of transport, ministry of the interior, ministry of civil works, ministry of environment, ministry of public administrations), national, federal State, regional road organisations and municipalities

— Additional primary stakeholders in case of conurbation TMPs:
  - Local traffic control centre and other involved departments of cities and municipalities
  - Local police / local forces of law and order
  - Local public transport organisation
  - Car park operators
  - Event organisers (e.g. fairs)
  - Maritime port and inland port authorities
  - Railway authorities
  - Airport authorities
  - Local press and broadcasting companies

4.8.3.6.2 TMP elaboration phase processes

TMP Feasibility study process

Possible initial situations are:

— Existing (traffic) situations including type, number and distribution of incidents

— Potential emergencies and expected incidents (preventative)

— General (political) objectives

Organisational requirement:

— **OR2**: For the TMP Feasibility study process the following (or comparable) process steps **should** be executed:
  - Definition of common policy goals and common interests, consideration of legal bases, regulatory framework

- Identification and analysis of the influence area (geographic area) which is often variable and dependent on the incident type and duration (capacity reduction) and the affected resource (network capacity)
- Identification and analysis of bottlenecks, in accordance with the OE-classification (sections of an acceptable route with a traffic capacity substantially below that characterizing other sections of the same route).
- Inventory of existing (road rail harbour and other) infrastructure (capacity, technical control and equipment packages, communication, topology, traffic ability for different vehicles, planned extensions)
- Statistical surveys of traffic volumes and speeds (if possible, including aspects of traveller behaviour)Survey of traffic characteristics (share of vehicle types, share of local, regional and long-distance traffic, destination of traffic etc.)
- Approach for detecting incidents:
  - Preliminary detection of problems / incidents (possible proceedings: interviews with experts, analysis of traffic messages, incident database, calculation of the estimated occupancy, control tours, analysis of system data)
  - Manual / Real-time detection
  - Inventory of existing and planned monitoring systems, control systems and information systems
  - Definition of current, planned and necessary additional technical infrastructure

TMP development process

Organisational requirement:

— **OR3:** For the TMP development process the following (or comparable) steps **should** be executed:

- TMP development
  - Categorisation of incidents, definition of incident thresholds for activation of a TMP
  - Definition of other thresholds / conditions for TMP activation at the local and cross-organisational levels
  - Development of methods for detection / control
  - Location codes and geo-referencing frameworks
  - Development of measures and actions
  - Strategy prioritization in case of overlapping strategies / interests
  - Strategy transitional phases, if needed
  - Thresholds / conditions for activation and deactivation
  - Development of computerised decision support tools such as traffic situation and impact modelling and strategy selection advisor, when necessary
  - Organisational / technical aspects of evaluation / quality management
  - Update and refinement of developed TMPs
  - Formal approval of strategies and measures
  - Set up of organisational structure for full-scale elaboration and monitoring
  - Full-scale elaboration of TMPs
- TMP validation by stakeholders, piloting refinement
  - Formal approval of strategies and measures
  - Set up of organisational structure for full-scale elaboration and monitoring
  - Field testing of TMPs (if possible)
  - Update and refinement of developed TMPs
  - Full-scale elaboration of applicable TMPs

4.8.3.6.3 TMP regulatory framework

Common Partner Arrangement / Memorandum of Understanding (MoU)

Clear definitions of organisational aspects are a crucial precondition for the successful implementation of a TMP service and should be documented and agreed upon by all involved parties/partners in the form of a Common Partner Arrangement / MoU which fixes the co-operation.

However, due to the fact that the partners are public or private road organisations who are legally autonomous to varying degrees and, in the international context, sometimes even work on different national laws, it is not required to define organisational aspects on a legal and binding basis.

The documents should define the modes of co-operation and must contain operation instructions for the afore-mentioned aspects. Thus, they should be thoroughly verified before signature. Both documents are a declaration of intent to fulfil them but are not legally binding. The appointment should be concluded in written form, on the one hand because it requires a clear common understanding of the cooperation and on the other hand because the signing of the contract can be seen as a milestone with media impact. For an example, see Annex B.

As content of the Common Partner Arrangement / MoU rules of procedure should be determined answering the following questions:
- Who are the points of contact within the participating TCCs?
- What media (incl. fall back) is used for systems for scenario / strategy co-ordination?
- Which language is used for scenario / strategy co-ordination?
- Who is allowed (and bound) to request a strategy under which conditions?
- What degree of flexibility is allowed under each pre-defined strategy?
- Who is allowed to accept or reject the strategy?
- How to proceed if one partner does not agree the strategy activation?
- How to proceed if one partner does not answer? (time-out procedure)
- Do the partners have to justify their decision?
- Is it desired that partners get insight into the traffic situation of each other?
- How to proceed if the traffic management centres have different operation times (e.g. during the night)?
- Which strategy has priority in case of overlapping activations?

Through a detailed technical annex the Common Partner Arrangement / MoU should contain the list of scenarios, activation and de-activation thresholds, organisational structure, communication templates, operating protocols, etc., to be evaluated and updated on a regular basis.

Organisational requirement:
- **OR4:** For the successful implementation of a “Traffic Management for Corridors and Networks service” all necessary organisational aspects **should** be documented and agreed by all involved parties/partners to fix the co-operation

Organisational advice:
- Preceding the finalisation of the documents and the agreement upon the co-operation extensive off-line and on-line testing of proposed TM strategies and measures should be executed to refine and validate the process, prior to agreeing a formal long-standing process.

Public-private partnerships

A new challenge is the ever-increasing number of public-private partnerships in the field of traffic management. Here, where private stakeholders execute sovereign tasks or receive data, binding contracts should be developed and signed. Another relevant aspect is the use of privately generated data for traffic management. A contract (with service level agreement) should be a MUST wherever the TMP relies on receiving privately generated data.

Organisational requirement:

— **OR5**: In the case of involving private partners for the delivery of privately generated data for a Traffic Management for Corridors and Networks service, a service level agreement **should** be developed and closed wherever a TMP relies on receiving privately generated data

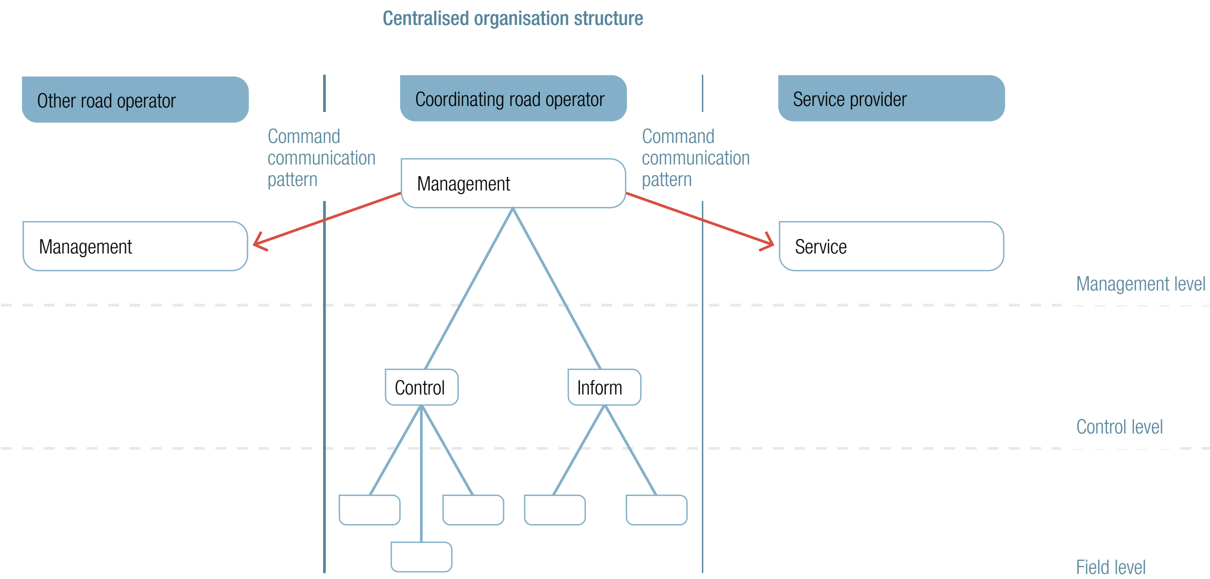
4.8.3.6.4 Forms of service operational organisation

Different organisational structure principles exist to manage the service operation:

Centralised operational organisational structure

In this structure, the coordinator is obliged to decide about the activation and deactivation of the TMP. According to specific conditions, the partner has to carry out the actions under his command.

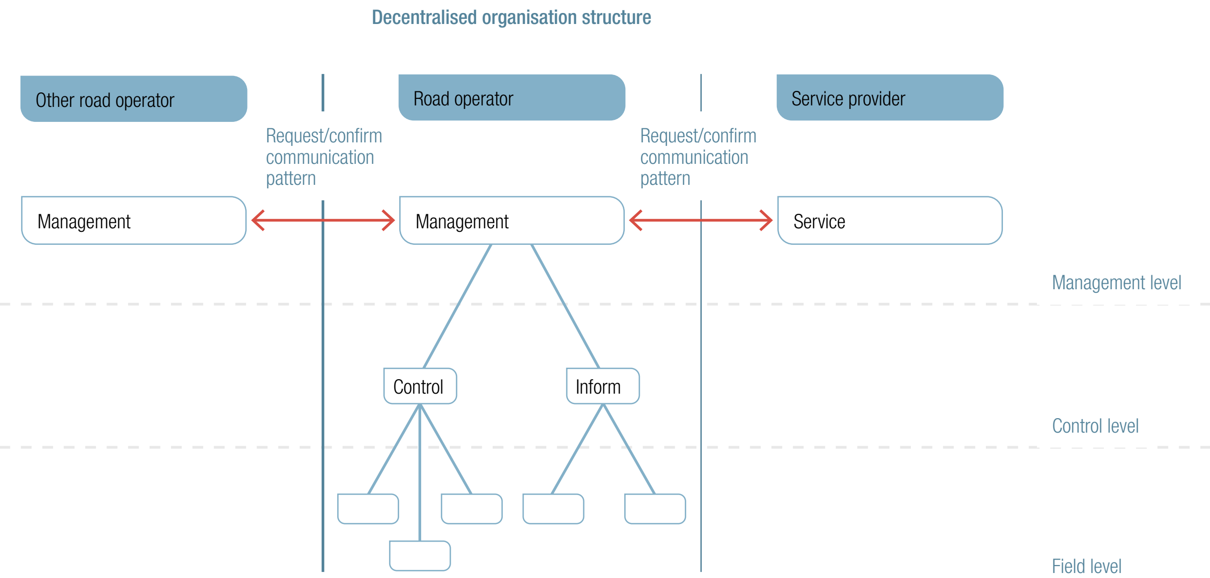
Figure 98: **Centralised service value chain organisation**



Decentralised operational organisational structure

In this organisational structure, TMPs are applied in close collaboration between legally autonomous partners. The scenario is requested from the partner affected by the incident. It can be accepted or rejected from every collaboration partner with varying rights according to the MoU agreement.

Figure 99: **Decentralised service organisation**



Mixture of centralised and decentralised operational organisational structure

Several organisations involved are structured differently at various levels of event information and TMP activation / deactivation communication. This also includes special forms of organisations in which private parties are contractually included to manage TMPs.

Organisational requirement:

— **OR6**: Stakeholders involved in service operation **must** agree on one of the following operational organisational structures:
- centralized structure
- decentralized structure
- mixture of centralised and decentralised structure

4.8.3.7 Common Look & Feel requirements and advice

TMP elaboration document structure

Common Look & Feel requirement:

— **CL&FR1:** In order to facilitate the comprehension of TMP documents between various bodies they **should** respect the common structure of the TMP framework document (intermediate deliverable 2), called TMP Fact Sheet (see Table 44 and Table 45):

Table 40: **Traffic Management Plan - Fact Sheet (Example URSA MAJOR, page 1)**

TRAFFIC MANAGEMENT PLAN - FACT SHEET	
Version & date of issue	
GENERAL INFORMATION ON THE TRAFFIC MANAGEMENT PLAN (TMP)	
Name:	
Status:	design ☐ draft ☐ consultation ☐ approved ☐
Date of implementation:	in operation since _______________
Initial situations for TMP application:	e.g. extreme weather conditions, congestions, full road closures, road works, restrictions for HGV traffic
Traffic management measures which are applied:	e.g. traffic information, HGV storage, rerouting
TMP DESCRIPTION	
SPATIAL ASPECTS	**International, cross-border ...**
Network involved	Normal route Alternative route(s) Length of main and alternative route Average travel time Capacity (also storage)
Influenced area: description (If roads in a country are listed, please place a country letter behind the road. For example, A12(B) is Belgium and A12(D) is Germany. If available, E-road numbers should alw ays be mentioned)	Map (Please use the same colour code in all maps. See examplary TMP: green for the normal route, blue for the national route and red for the international route.)

Table 41: **Traffic Management Plan - Fact Sheet (Example URSA MAJOR, page 2)**

ORGANISATIONAL ASPECTS				
Partners and bodies involved:	e.g. road operators, traffic management centres, police etc.			
Regulatory framework:	e.g. MoU, LoI, cooperation agreement, working instructions			
OPERATIONAL APPROACH				
Events/incidents				
Event/incident type:	e.g. accidents, bad weather or snow, road works, HGV restrictions			
Event/incident location and road number:	e.g. A12(D)			
Scenarios	**e.g. Information only**	**e.g. Rerouting national**	**e.g. Rerouting international**	
Scenario name:				
Spatial application:(area and network)				
Thresholds for activation due to latency and/or expected delay:				
List of possible associated measures:				
Organisations to be involved:				
Associated Measures	**e.g. Information of delay time**	**e.g. Information to reroute via...**	**e.g. Information to reroute via...**	
Associated Actions				
Assosiated VMS/Actuators				
Assosiated VMS/Actuators				
COMMUNICATION PLAN				
Target audiences (end-users)				
Resources required:				
TECHNICAL ASPECTS:				
Communication between the partners:	e.g. fax, phone, mail & frequency			
Decision support system used:	yes/no			
Road-side systems and systems to inform the traveller:	e.g. VMS, RDS-TMC, radio, internet, television			
CONNECTION TO OTHER TMPs:				
What are the ‚neighbouring' TMPs that could possibly be influenced by the activation of this TMP?				
Evaluation references (if available)				

4.8.3.8 ICT Infrastructure requirements

No specific requirements or advice.

4.8.3.9 Required standards and specifications

Information provision standards:
- **IPS1a:** If the Traffic Management service for Corridors and Networks provides TMP scenarios at interface 1 (see IFR1a), they **must** be profiled based on CEN/TS 16157-8:2020 (DATEX II).
- **IPS1b**: If the Traffic Management service for Corridors and Networks provides TMP'S in operation at interface 1 (see IPR1b), they **must** be profiled based on CEN/TS 16157-8:2020 (DATEX II).
- **IPS2**: If interface 2 is implemented Traffic Management for Corridors and Networks information (see IFR2) **must** be profiled using an IVIM based on ISO 19321 using the C-ROADS C-ITS Message Profiles for the In-Vehicle Signage service.
- **IPS3**: When relevant, the Probe Vehicle Data (microscopic traffic situation) information (see IFR3) **should** be collected, which is profiled based on ETSI EN 302 637-2 using the CAR2CAR Communication Consortium Basic System Profile.

4.8.3.10 Level of Service Definition

4.8.3.10.1 Level of Service Criteria

Table 42 gives the Level of Service recommendations for a Traffic Management for Corridors and Networks service. The background of this concept is descripted in chapter 2.6.

Table 42: **Level of Service recommendations for Traffic Management for Corridors and Networks**

Level of Service criteria table: Traffic Management for Corridors and Networks			
Core Criteria	**A**	**B**	**C**
Coverage	Critical spots coverage	Spatial expansion of the service, linkages	Total network coverage (all critical spots)
Availability to time	Service periodically ensured during critical periods	Extended availability, when required	Service 24/7 ensured
System* availability	One sole system available	Diverse systems	Diversity of systems: consistent information and traffic management measure support
Consistency	Consistent road user guidance at local level	Consistent road user guidance along the routes	Global consistency of road user information through any media along the route
European network approach	Knowledge and scenario sharing between neighbouring regions	Cross-border scenario consistency	Coordinated deployment of common measures, including conurbation areas
* Traffic control und guidance systems, event and traffic condition and travel time information systems			

4.8.3.10.2 Level of Service Criteria related to Operating Environment

LoS requirement:

— **LoSR1:** In the case that pre-deployment surveys / evaluations provide the necessary evidence to proceed with the deployment of the ITS-service "Traffic Management for Corridors and Networks", the minimum and optimum LoS should respect the following Level of Service to Operating Environment mapping table.

Table 43: **Level of Service to Operating Environment mapping table (see also chapter 2.5.3 and ANNEX C)**

TRAFFIC MANAGEMENT FOR CORRIDORS AND NETWORKS			Operating Environment													
Criteria for the Level of Service			C1	T1	T2	T3	T4	R1	R2	R3	R4	S1	S2	N1	N2	P1
Coverage	C	Total network coverage (all critical spots on the network)										O	O	O	O	O
	B	Spatial expansion of the service, linkages			O	O	O		O	O	O		M		M	
	A	Critical spots coverage	OM	OM	M	M	M	NA	M	M	M	M		M		M
Availability to time	C	Service 24/7 ensured	O										O		O	
	B	Extended availability	O			O	O					O		O	M	OM
	A	Service periodically ensured during critical periods	M	OM	OM	M	M		OM	OM	OM	M	M	M		
System Availability	C	Diversity of systems: consistent information and traffic management measure support										O		O		O
	B	Diverse systems	O		O	O	O		O	O	O		O		O	
	A	One sole system available	M	OM	M	M	M	NA	M	M	M	M	M	M	M	M
Consistency	C	Global consistency of road users information through any media along the routes										O	O	O	O	
	B	Consistent road user guidance along the routes														O
	A	Consistent local road user advice along routes	OM	OM	OM	OM	OM	NA	OM	OM	OM	M	M	M	M	M
Level of Coordination	C	Coordinated deployment of common measures, including conurbation areas														
	B	Cross-border scenario consistency		O	O	O	O					O	O	O	O	O
	A	Knowledge and scenario sharing between neighbouring regions	NA	M	M	M	M	NA	OM	OM	OM	M	M	M	M	M

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

5

F&LS - Freight & Logistic services

5 F&LS - Freight & Logistic services

5.1 F&LS-Introduction

The Freight & Logistics sector is a major enabler of global trade and vital for economic growth. It transfers products from origin to destination using a supply chain network consisting of road, rail, air- and waterways. Road transport is not only used for the last mile, i.e. delivery to the final destination, e.g. to a specific address within a city, but it proves to be especially efficient in many cases, e.g. when dealing with intra-European trade, connecting between nodes etc. Road freight transport constitutes a significant part of road traffic nowadays and constantly grows further.

The Core European ITS Services for the Freight & Logistics sector have the goal to assist drivers and road transport companies in dealing with two major issues:

— Truck parking availability
— Cross-border transport of oversize/overweight loads

The need for truck parking is mainly mandated from the driving time regulations that the drivers need to comply with. As the drivers cannot exceed the allowed driving times, they need to find a place to safely park and take a short or longer break, as needed. Other reasons also apply, such as waiting times for loading/unloading on nodes. Although the economic growth in the last decades has led to a significant growth of road freight transport, the availability of truck parking places has not followed suit, leading to a lack of truck parking spaces. Therefore, the need to better manage the available truck parking spaces is nowadays more important than ever before.

The Core European ITS Service "Intelligent and Secure Truck Parking" has the goal to offer a better management of truck parking services by providing to the driver information and guidance through static and dynamic information on truck parking availability and facilities on-site, as well as the possibility to make an advance reservation of a parking space are considered in this service. Therefore, this service contributes to the observation of rest and driving periods for drivers, the reduction of illegal/dangerous parking and the improvement of the safety and security of the vehicle, driver and load.

The second issue covered in this chapter is the transport of *abnormal* goods, a term that refers to the transport of loads of exceptional size and/or weight. The planning of abnormal goods transport throughout Europe is not a simple task for logistic companies. Each country has its own regulation on the matter, with different authorized dimensions and weights. For loads that exceed these values, a special permit is required. For EU member states, the Council Directive 96/53/EC provides information about the permissible dimensions and weights for certain road vehicles in international traffic. Vehicle combinations (trucks with ordinary trailers or semi-trailers) which comply with the criteria specified in this Directive may travel on roads within the EU without a special permit.

The application procedure to apply for a permit for oversize/overweight transport varies from country to country. In some countries there is an online procedure, in others not. The language barrier can also pose additional problems to the applicants, as in some cases the applications are only available in the national language or in a few other languages as well.

The objective of the Core European ITS Service “*Abnormal Goods Transport Regulations*” is to provide a portal that offers all the relevant national characteristics for abnormal transports in the EU Member States in a reliable, comprehensive, and interactive manner, in order to provide all the requested information needed for particular transport permits and the contact data for all relevant authorities.

The two ITS Services shortly described above are presented in detail in the subchapters that follow.

5.2 F&LS-01 Intelligent and Secure Truck parking

5.2.1 ITS service at a glance

ITS Service definition

Two different services with regard to intelligent truck parking are considered:

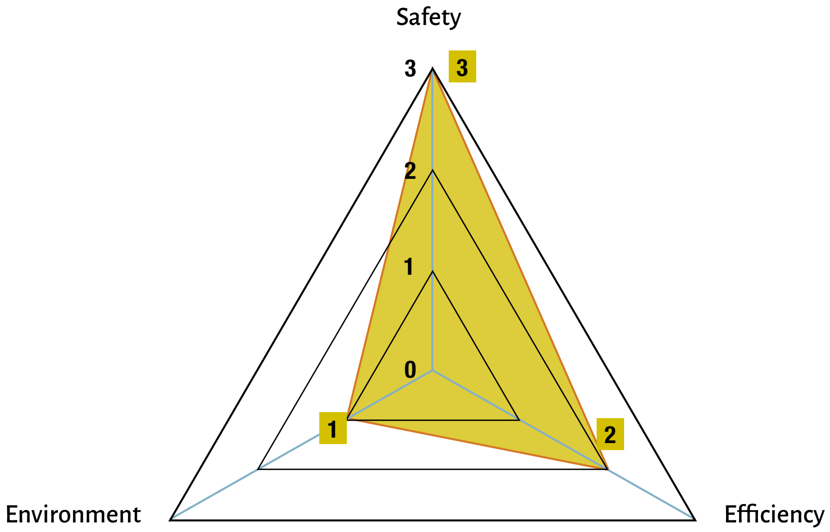
- Information and guidance (on truck parking areas)
- Reservation (of truck parking spaces)

Production and distribution of static and dynamic information on the truck parking situation on the TEN-T networks and access roads to manage the parking space, support the observation of rest and driving periods for drivers, reduce dangerous parking and improve drivers, load and goods vehicle safety and security. This information could be provided on-trip and pre-trip using different information channels and different end-user devices.
Beyond that the service can be combined with the individual reservation of a truck parking space with the help of telematic services via different devices. A parking space on site is reserved (blocked) and kept free for the pre-identified goods vehicle.

ITS Service objective

The main objective of providing information to the end user is improving the safety and the efficiency of the parking areas and the safety and security of truck drivers.
ITP is useful in sections where demand and capacity is nearly balanced but has many rest areas. The drivers need information which of the available rest area provides free parking spaces. ITP then reduce construction of new rest areas or parking lots on existing rest areas.
If the truck drivers know the upcoming parking situation in advance they would be prepared and could pro-actively change their route or park earlier. Parking information can be factored into both pre- and on-trip journey planning. This may change the parking times, assist the truck driver to take more effective routing decisions. Better-informed truck drivers find a safe and secure parking place more easily, sleep well and hence benefit from improved concentration.

ITS service radar



ITS service key words

Intelligent truck parking, ITP

5.2.2 ITS service profile

5.2.2.1 General ITS service description

The objective of parking area operators is to make the optimum use of the existing truck parking capacities along the highways and to improve safety and security on their (truck) parking area. "Intelligent Truck Parking" (ITP) will contribute towards optimising the use of available parking areas, which are a limited resource in many corridors today. The service will also enable efficient management of roads and parking areas which may become congested or overloaded with goods vehicles at certain times due to traffic/driving restrictions, weather or road conditions.

On-site guidance allows the goods vehicles to park without spending a long time looking for a place.

End users may receive all of the information they require to park their goods vehicles through various information channels, if necessary, across borders. Access to properly equipped parking and rest areas will reduce the risk for driving on "overtime", will reduce driver fatigue, improve cargo security, and solve other problems relating to excessive driving periods and "wild" overnight parking. This in turn will reduce the sanitary, safety and security problems affecting truck drivers.

The specific needs of individual transport operators need to be borne in mind, such as those carrying dangerous goods or abnormal loads.

Reservation services support the individual reservation of a truck parking space with the help of ITS services on board of the goods vehicle via internet, call-centre and smartphone app. The parking space on site is reserved (blocked) and kept free for the identified goods vehicle.

5.2.2.2 What is the Vision?

The main objective of providing information to the end user is improving the safety and the efficiency of the parking areas and the safety and security of truck drivers.

ITP is useful in sections where demand and capacity is nearly balanced but has many rest areas. The drivers need information on which of the available rest area provides free parking spaces. ITP thus can reduce construction of new rest areas or parking lots on existing rest areas.

If the truck drivers know the parking situation ahead in advance they will be prepared and can pro-actively change their route or park earlier. Parking information can be factored into both pre- and on-trip journey planning. This may change parking times and assist the truck driver to take more effective routing decisions. Better-informed truck drivers find a safe and secure parking place more easily, sleep well and hence benefit from improved concentration.

5.2.2.3 What is the mission?

ITP for truck parking areas:
— is to inform the truck driver about static and, where necessary and available, dynamic information relating to truck parking areas in order to support drivers in locating parking areas and/or free parking lots
— is only required where is a lack of capacity

Reservation for truck parking lots:
- is to reserve a parking space by time.

This information could be provided on-trip and pre-trip using different channels of information and different end-user devices. The service may comprise common information as well as personalised (individual) information.

Problems to consider:
- insufficient detection methods
- easy information access for the road user is unavailable
- diversity of information portals with different presentations
- incompleteness of information
- diverging interpretation of or disregard for the information by the road user

The implementation of an ITP system has to be considered globally regarding the context of the area and the level of saturation in the areas. In some countries or regions, building new parking spaces or new parking areas is more economic than investing in ITS solutions for truck parking management. The main problem is in the detection of the occupancy of the areas. Equipping a truck area with an ITP system costs a lot of money. Road or area operators are not ready to spend this money because the ROI generated by this investment is very low - parking is free for the drivers in a lot of countries. Moreover, free truck parking doesn't encourage other stakeholders (e.g. logistics platforms, or certain hauliers) to invest in truck parking areas. Motorway truck parking areas on the motorways are sometimes considered as logistics storage.

5.2.2.4 Distinctiveness to other ITS-services

Relevant complementary information is covered by another ITS Core service:
- Multimodal Travel Information Service (TTIS-05)

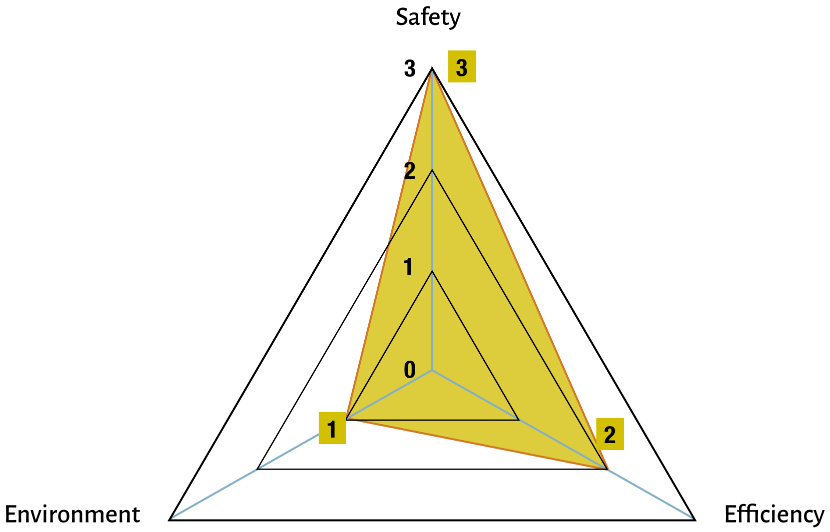
This service is directed to the road user and may include general information as well as personalised (individual) information. The information provision should be in accordance with any traffic management plans (see TMS-07), which are in operation by the specific road authorities or traffic management centres.

5.2.2.5 Contribution to overarching European ITS objectives

ITS-Service radar

The graph below provides a quantification of the added value of "Intelligent and Secure Truck Parking" services regarding safety, efficiency and the environment.

Figure 100: **Service radar "Intelligent and secure truck parking"**



Safety

It is anticipated that the provision of truck parking information to the driver/ haulier will help improve road safety and Truck Parking Area safety. The service can significantly contribute to the prevention of accidents related to offsite parking, fatigue and stress.

A study[37] that included an investigation of accidents taking place involving parked trucks shows the positive impact of the service with regards to safety: While the sample is relatively small, it is assessed that 50% of these accidents could have been avoided or have significantly smaller consequences had the trucks parked in a safe parking lot.

Stress and fatigue, both factors contributing to accident risk, can also be reduced by being able to more easily find a safe parking space through better guidance and more efficient use of existing parking areas.

Environmental impact

The provision of information relating to alternative parking areas may help reduce time spent looking for available parking lots, which in-turn will help to further decrease the CO_2 emissions. There could also be benefits to environmental impact where identified parking could lead to less unacceptable behaviour by drivers who cannot find appropriate facilities to park.

In addition, ITP enables more efficient use of existing parking areas and thus contributes to the reduction of the need of building new Truck Parking Areas. Finally, the contribution of the service to safety/reduction of accident risk also has a positive effect for the environment through the reduction of the risk of accidents involving hazardous goods.

37 The full study can be found here: ITS Action Plan – Priority Actions E and F - Information and Reservation Services for Safe and Secure Parking Places for Trucks and Commercial Vehicles - Final Report

Network efficiency

ITP will increase the overall efficiency of the Truck Parking Areas on a road sector/corridor. In addition, efficiency improves through reduced time spent and km driven while searching for a parking lot, as well as from reduction of off-site parking and queuing.

5.2.3 Harmonization Requirements and advice

5.2.3.1 Service Definition

In most European countries the truck parking areas available are predominantly operated without the use of ITS or telematic services.

Following the adoption of Delegated Regulation 885/2013 on the provision of information services for safe and secure parking places for trucks and commercial vehicles, an increasing number of countries have established a National Access Point for this type of data. For designated areas where traffic and security conditions require the deployment of information services on safe and secure parking places, the National Access Points are obliged to contain static parking information and information on safety and equipment of the parking area. For defined priority zones, where there is a shortage on safe and secure parking places, also dynamic parking data should be included in the National Access Points (when available). Data should be provided both by public and private truck parking operators.

This service description addresses the production and distribution of static and dynamic information on the truck parking situation on the TEN-T networks and access roads to manage the parking space, support the observation of rest and driving periods for drivers, reduce dangerous parking and improve drivers, load and goods vehicle safety and security. This information could be provided on-trip and pre-trip using different channels of information and different end-user devices.

Beyond that the service can be combined with the individual reservation of a truck parking space with the help of telematic services via different devices. A parking space on site is reserved (blocked) and kept free for the pre-identified goods vehicle.

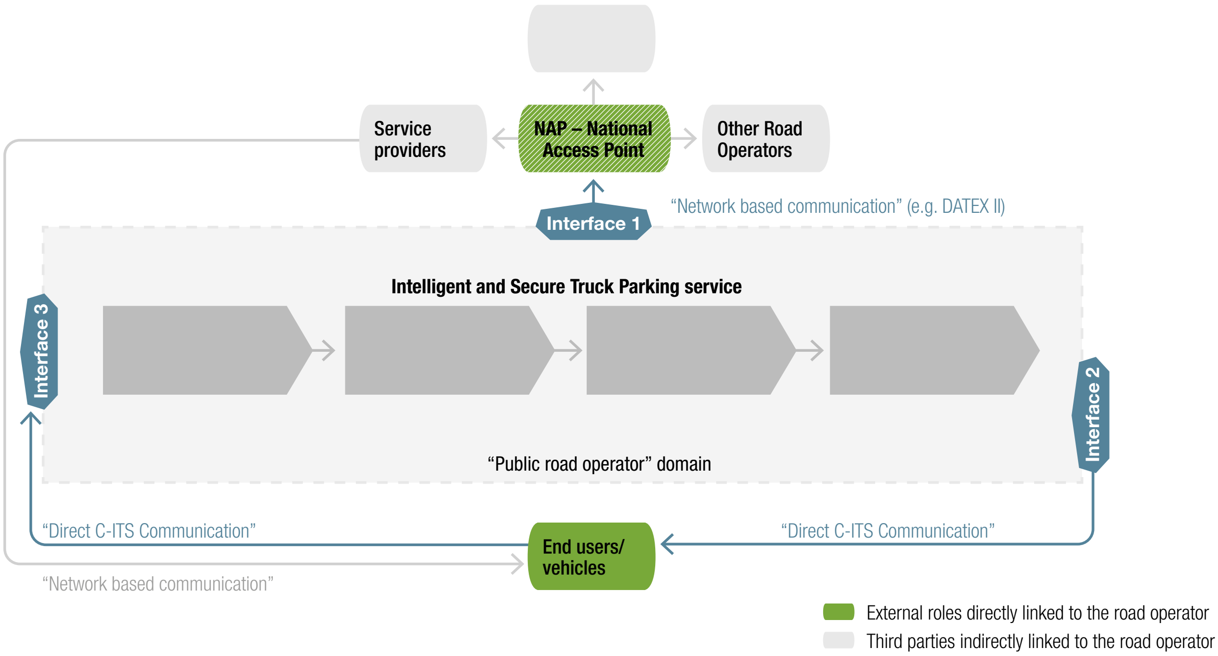
5.2.3.2 Functional requirements and advice

5.2.3.2.1 Functional architecture

Goods vehicle drivers and dispatchers need information on fuel stations and rest areas on their route both before and during their trip. This may be done through the information providers. In Europe, private and public information providers are involved in this information provision (see organisational requirements).

The figure below shows the typical functional architecture of the information service. The vertical lines show where it is appropriate to segment the whole functionality of the service into a maximum of three sub-functions.

Figure 101: **Functional architecture of the Intelligent and Secure Truck Parking service**



5.2.3.2.2 Functional requirements and advice

Sub-function 1 "Data collection (static/dynamic)"

The devices and methodologies for traffic data collection are not covered by this service description. Amongst other considerations they depend on the particular data collection system used and are left to the operator to select. Note that even dynamic data collection isn't only done by automatic systems. Note that the number of spaces must be defined by the operator.

Functional requirements:

— **FR1**: The data provided for static information **must** be based on a consistent and geographic reference mode, which must be part of data description.

— **Note:** In compliance with Delegated Regulation (EU) 885/2013, the geographic references must include latitude/longitude information of the entry point in the parking area, primary road identifier/direction (plus a second primary road identifier/direction, if the parking area is accessible from two different roads) plus - if needed - the indication of the exit to be taken from the primary road plus distance to the parking area in km or miles.

— **FR2**: The geographical basis for static and dynamic information **may** be left to the involved partners to define.

Sub-function 2 "Management of Information"

Within Europe different methodologies exist to manage the static and dynamic data. These methodologies are not covered by the present guideline and are left to the operator to select. They depend amongst others on the (until now) covered data and the need to offer it.

Functional requirement:

- **FR3:** Source, scope and quality of data provided **must** be defined and **must** be part of data interface description.
- **FR4**: The geographical basis for dynamic information **must** be the same or compatible as the one for static information.
- **FR5**: The data provided **must** be based on a consistent and geographic reference model and a time validity model. For defined priority zones dynamic parking data must be included in the NAP (when available).
- **FR6:** Historic dynamic information data **may** also be required for algorithms or forecast.
- **FR7:** Data **should** be described using metadata[38] to make it easier to search data, to make the data machine-readable and to improve common understanding of the data.
- **FR8:** Data **should** be described in English language as a minimum and possibly also other languages.

Sub-function 3 "Transmission of Information"

Information provision is carried out by different service providers in accordance with specific business models. The information provision to the truck driver has to be done using various information channels e.g. on signs and end-user devices (see introduction). When providing customer-oriented forecast and real-time information services, the users' benefit can be increased by providing parking information combined with general traffic information (i.e. Traffic Condition and Travel Times (see TTIS-02), Road Weather Information (see TTIS-06) and Speed Limit Information (see TTIS-03)) as well.

Functional requirements:

- **FR9:** The geographical area of information dissemination **should** take into account the characteristics of the information transmission channel used.
- **FR10:** Traffic signs being used for information dissemination **must** be compliant with the requirements of the Vienna Convention on Road Traffic Signs, where a Member has signed it. This means that the colours red, yellow and green cannot be used to show "the degree of occupation" of the truck parking area. Signs with language dependent written messages such as "free" should not be used.
- **FR 11:** To foster interoperability between all parties involved (content providers/non-technical sources, service operators, service providers) the sub-function **may** provide interfaces conforming to the following information structure:
  - static information
  - dynamic information
  - comment (free text)
  - information source
- **FR 12**: According to Delegated Regulation 885/2013 article 5 public or private parking operators and service providers **must** share and exchange data in DATEX II (CEN/TS 16157) format or any DATEX II compatible international machine-readable format. Data shall be accessible for exchange and reuse by any public or private information service provider and/or parking operator on a non-discriminatory basis, and in accordance with access rights and procedures defined in Directive 2003/98/EC.

38 There are different 'standards' for metadata (coordinated metadata catalogue, DCAT-AP). A guideline on metadata is available here: https://www.its-platform.eu/filedepot_download/1976/6295

Functional advice:

- It is recommended that the capacity of the parking area is defined in relation to the measures of goods vehicles.
- The provision of the static information requires maintenance and availability of a list or a database as well as regular, systematic data maintenance.
- It is recommended that truck parking facilities beside the highway preferably are not farther away than 1 km from exit[39].
- The automatically detected data may subsequently be further improved by the relevant algorithms to achieve good dynamic information without manually calibrating the system very often (e.g. comparison with historical data, with account of the physical upper and lower limits for occupancy). In addition, it is recommended to regularly calibrate the number of free truck parking spaces.
- It is recommended that dynamic data has a time stamp and information regarding its quality (period of validity).
- It is recommended that the smallest possible deviation from the actual/planned status is available about 1 hour before the full occupancy of the parking area. This is when the demand for dynamic data is the highest and the information for the users is the most valuable.

5.2.3.3 Interface requirements

Interface requirements: static information according Delegated Regulation (EU) 885/2013 Article 4 paragraph 1 and 2

- **IFR1a:** The Intelligent and Secure Truck Parking service **must** provide at interface 1 (see Figure 101) basic static information according to Delegated Regulation (EU) 885/2013 Article 4 paragraph 1 and 2:
  - Identification information of parking area (name and address) (200 characters)
  - Location information of the entry point in the parking area (20+20 characters)
  - One or two primary road identifier/direction pairs, depending on whether the parking area is accessible from one or two different roads (20+20 characters each).
  - Indication of the exit to be taken (100 characters) and distance from primary road in km or miles (3-digit integer)
  - Total number of parking places for trucks (3-digit integer)[40]
  - Price and currency of parking places (300 characters)
  - Description of security, safety and service equipment of the parking including national classification if one is applied (500 characters)
  - Number of parking places for refrigerated goods vehicles (numerical 4 digits)
  - Information on specific equipment or services for specific goods vehicles and other (300 characters)
  - Contact information of the parking operator
    - Name and surname (100 characters
    - Telephone number (20 characters)
    - E-mail address (50 characters)
    - Consent of the operator to make his contact information public (Yes/No)

39 It should be noted that recent (2017) stricter interpretation of the driving time regulation might lead to truck parkings farther away.

40 The current text of 885/2013 is phrased “number of free parking spaces”. This seems to be either an editorial error or a very ambiguous phrasing, since this is the section for static data. What is meant is the total number of spaces, independent of the current occupancy.

Note: For the collection, processing and storage of information the General Data Protection Regulation (GDPR) applies[41].

— **IFR1b:** The Intelligent and Secure Truck Parking service **should** provide at interface 1 (see Figure 101) advanced static information about the parking area type:
  - truck only/ "combined" parking facility (including non-goods vehicle)
  - number of spaces for cars, busses (defined by operator)
  - service features (facilities, fuel card, security[42])

Interface requirements: dynamic information according Delegated Regulation (EU) 885/2013 Article 4 paragraph 3:

— **IFR1c:** The Intelligent and Secure Truck Parking service must provide at interface 1 (see Figure 101) DATEX II or any DATEX II compatible international machine-readable format coded dynamic information including the dynamic data on availability of parking places including whether a parking is:
  - full,
  - closed or
  - number of free places which are available.

— **IFR2**: If interface 2 is implemented, the Intelligent and Secure Truck Parking service **must** provide at interface 2 (see Figure 101) truck parking information coded in C-ITS messages including the following elements:
  - full,
  - closed or
  - number of free places which are available.

— **IFR3**: When relevant, the Intelligent and Secure Truck Parking service **should** collect at interface 3 (see Figure 101) C-ITS coded Probe Vehicle Data information (microscopic traffic situation) relevant to this ITS Core service.

5.2.3.4 Organisational Requirements

Note: A general overarching description of the key actors, their roles in the value chain and the related conditions for TTI service provision are outlined in Chapter 3.1.4.

Organisational requirements:

— **OR1:** The organisational and operational structure of the service as well as the role of each organisation/body and its exact tasks in the chain **must** be defined. These parties and their role in the organisational structure of the ITP-service demand special attention and finally agreements/ contracts.

— **OR2:** Contracts/agreements **must** be established, which set up the rules of cooperation.

— **OR3:** Collaboration processes/workflows and interfaces **must** be described.

— **OR4:** The information provision **should** be in accordance with any management plans which are in operation of the road authorities or traffic management centres.

— **QR5:** A Quality Management and Assessment of compliance with the requirements systems **must** be set up according to Articles 7 and 8 of Delegated Regulation (EU) 885/2013. Details of these procedures **must** be clarified with the designated national competent body in charge of assessment of compliance with Delegated Regulation (EU) 885/2013.

41 More information: www.gdpr.eu

42 An example reference for security features is the „Study on Safe and Secure Parking Places for Trucks": https://ec.europa.eu/transport/sites/transport/files/2019-study-on-safe-and-secure-parking-places-for-trucks.pdf

Organisational advice:

- Since static data is subject to continuous change, a systematic standardised maintenance of the data is recommended.
- It is recommended to robustly calibrate dynamic data at regular intervals. The frequency of calibration depends on the requirements of the users, the accuracy of the detectors, the number of entering and departing goods vehicles, and the algorithm employed. In the case of daily calibration (which illustrates major discrepancies) it is recommended to calibrate shortly before the area is fully occupied.
- It is not legally possible in all Member States to restrict the general use of public parking areas through the reservation for individual users. In these countries only private sector solutions are conceivable.

5.2.3.5 Common Look & Feel requirements

Goods vehicle drivers and hauliers want to know where to find the right general information in language independent and comprehensible form. Roadside information must be provided in a language independent form, and be consistently designed so as to be understandable throughout Europe.

There are private internet platforms, which enable the driver or forwarder to book truck parking spaces. As an alternative this can also be done by telephone. A charge for the reservation has to be expected.

A possible pictograph for security information has been developed, reference: EU resolution on preventing and combating road freight crime and providing secure truck parking areas (Council Meeting of the Ministers of Justice and Home Affairs; 8 and 9 November 2010).

In the EasyWay project, the expert group on VMS harmonisation had obtained good results for one-pictogram signs specifically indicating parking for trucks various comprehension tests. This eases the use of VMS concerning ITP for all one-pictogram VMS available in Europe (the majority of VMS devices).

Common Look & Feel requirements:

- **CL&FR1:** Information for the end user **must** be consistent, whatever media or end user device is used for distribution.
- **CL&FR2:** The display of signs/pictograms on VMS or other end-user devices **should** be in accordance with prevailing national road codes and:
  - Member States which ratified the Vienna Convention MUST respect the Vienna Convention and the European agreement supplementing the convention (1st May 1971) and SHOULD consider the Consolidated Resolution on Road Signs and Signals (R.E.2).
  - Member States which did not ratify the Vienna Convention SHOULD follow the Vienna Convention and also consider the R.E.2.

5.2.3.6 Required standards and specifications

- **IPS1:** If a Service for Intelligent and Secure Truck parking is implemented at interface 1 the information (see IFR1) **must** be profiled based using the “DATEX II Profile for Truck Parking” defined in CEN/TS 16157-6:2016 or any international machine-readable format fully compatible and interoperable with DATEX II.

5.2.3.7 Level of Service Definition

5.2.3.7.1 Level of Service Criteria

Table 44 gives the Level of Service recommendations for an Intelligent and Secure Truck Parking service. The background of this concept is descripted in chapter 2.6.

Table 44: **Level of Service recommendations for Intelligent and Secure Truck Parking**

Levels of Service criteria table: Intelligent and Secure Truck Parking[45]						
Core Criteria	**0 (no service)**	**A**	**B**	**C**	**D**	**E**
Information on truck parking areas	None	Basic static	Advanced static	Real-time (dynamic)	Real-time and forecast for one point	Real-time and forecast for a section/for a trip
Transmission of information	None	Static Sign, maps	VMS for single site	VMS covering several sites, Internet, broadcast	On-Board technologies (App, telematic services)	
Reservation	None	Telephone	Web-based service via internet-browser	On-Board technologies (App, telematic services)		

The first thing to establish is what possibilities exist for truck parking management and what is necessary to solve existing problems. For the provision of information concerning truck parking, the following service levels have been defined: (**Note:** The levels of service for each criterion are independent. In this case, it is intended that higher levels of service offer greater capability than lower levels of service)

- Level A: Provision of basic static information on parking areas
- The trucker gets basic information about the location of existing truck parking areas, number of parking places, information on pricing, safety and equipment, and contact information via National Access Points, maps, navigation systems and signs along the principle roads.
- Level B: Advanced static information
- In addition to the basic information provided in level A, the driver gets more detailed information the available service on-site, such as toilets, fuel stations, restaurants, etc.
- Level C: Provision of real-time information
- Real-time occupancy information is provided to the road users. Occupancy information can be transmitted via several modes. The real-time information can be given for one area only or for several areas in a section/ on a corridor.
- Level D: Level C + forecast for one point
- Pre-trip information on the current number of total available parking spaces is provided via several modes. Occupancy forecast information is given depending on the current situation, the filling rate, the traffic density, local historic profiles and actual data. According to the estimated arrival time of a goods vehicle a forecast of free parking spaces is given. No guarantee can be given that there will be free parking spaces by the time the goods vehicle arrives.

43 The levels of service for each criterion are independent. In this case, it is intended that higher levels of service offer greater capability than lower levels of service.

— Level E: Level D + pre-trip and on-trip forecast information on a larger area
— On-trip information on the current number of total available parking spaces (per area) is provided via several modes, either on the roadside or through mobile devices etc. The forecast algorithm will take into account a larger area and several parking sites. This level provides a better short-term forecast with a wider reach than Level D and improves the possibility to seek alternative free parking spaces available in an area within the permitted driving time. This level offers the opportunity to adapt the route choice during planning in order to optimize the use of available driving time.

It is not imperative to try to achieve the highest level. For some route sections with a low demand for truck parking level A will be sufficient. If there is a demand for service offers level B has to be chosen. Only if the congestion of individual truck parking areas requires management of the parking area do levels C to E become economically useful for a better distribution of the demand for parking.

For the provision of information, the decisive factors are the (expected) demand of third parties, for example service providers, and the frequency of change of static data for the level to be chosen.

All data to be disseminated is purely informative and offered to about 20 % of the users of long-distance roads. For this reason, the erection of signs only for the transfer of information is excessive in view of the large number of truck parking areas, and as level A, it can only remain restricted to individual cases. For longer route sections the information may be presented to the driver in the vehicle cab. This is the only place where there is sufficient time to receive and evaluate this information and to react accordingly. Information channels can be used before and during the trip.

For detection within private areas, manual procedures with guards can also be economical. In other cases, automatic procedures/barriers would be appropriate. Downstream algorithms review the calculated number of free parking spaces. Historical comparisons and limit values (maximum and minimum capacity) offer themselves here.

For reservation, first the demand for such a service, along with the willingness to pay, has to be assessed. Then, depending on the total number of relevant truck parking areas (one or several), the economical level of use can be chosen.

5.2.3.7.2 Level of Service Criteria related to Operating Environment

Allocating the LoS to the operating environments is not useful for ITP. The necessity of ITP (stationary traffic) is not oriented towards the category of the road or the number of its lanes or whether it is prone to congestion, because these are the characteristics of moving traffic. Rather, the decisive factors are the number of goods vehicles that are on the road, the importance of the road and its position in the network with the resulting demand for truck parking spaces. This demand for parking has to be determined separately and locally. It results in the number of required truck parking spaces and the necessary relevant requirement of the individual ITP levels. Finally, the LoS are applicable to all OE´s.

The number of goods vehicles on the road has to be assessed with the availability in truck parking areas to be a good parameter for ITP deployment (e.g. there are motorways with low levels of truck traffic but also with very low truck parking availability and, consequently, often the problem of saturated truck parking areas.)

5.3 F&LS-02 Abnormal Goods Transport Regulations

5.3.1 ITS service at a glance

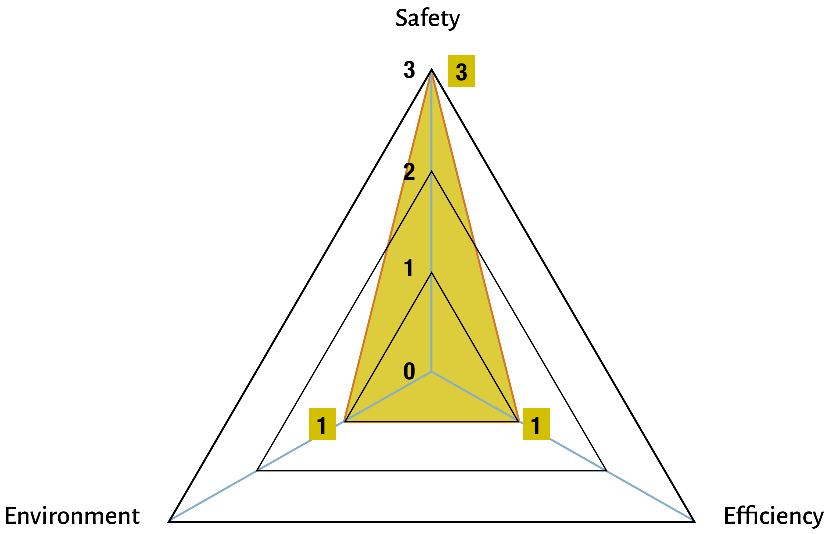
ITS Service definition

“Access to abnormal goods transport regulations” is an information service where the applicant gets country-specific information on the vehicle regulations and permit application procedures, contact persons, and guidelines for completing application forms for abnormal transports.
This service provides access to the necessary information and procedures regarding abnormal transports standardised for all European States, in a language understandable to the haulier/applicant (English and the respective national languages), and in a time frame acceptable to modern logistics.
In this service, both the necessary information and the contact details for the relevant authorities are easily accessible.

ITS Service objective

The objective of the Core European ITS Service is to provide a portal that offers all the relevant national characteristics for abnormal transports in the Member States in a reliable, comprehensive, and interactive manner, in order to provide all the requested information needed for particular transport permits and the contact data for all relevant authorities.

ITS service radar



ITS service key words

Abnormal goods

5.3.2 ITS service profile

5.3.2.1 General ITS service description

“Abnormal transports” are transports of no load or an indivisible load on vehicles or vehicle combinations that exceeds at least one authorised dimension or weight allowed in normal road traffic in the Member States where the transport will be carried out.

In the past years, traffic density has increased perceptibly, especially on the European roads. In addition, abnormal transports have also increased. The regulations for abnormal transports differ within the European countries. Furthermore, the application procedures, application forms and responsible authorities vary depending on the country.

As abnormal transport traffic increases, so does the administration effort. In particular, abnormal transports need a special permit issued by the responsible national authorities and the particular road operators from all Member States through which they want to pass. For each state, the applicant needs specific information on the regulations, permit procedures, contact persons and guidelines for completing the country-specific application forms.

The service aims to provide hauliers and truck drivers a single European portal or access point that will provide them the necessary information on abnormal transport regulations within the EU and links to national services and additional information. Examples of deployment are provided in the Deployment References Annex.

In summary, this service provides a general access to the main information and procedures regarding a specific abnormal transport, homogenised for all Member States, in a language understandable to the trucker/applicant (English and the respective national languages), and in a timeframe acceptable for modern logistics, supplying a direct link to the already existing different National web platforms.

5.3.2.2 What is the vision?

The objective of the Core European ITS Service is to provide a portal that offers all the relevant national characteristics for abnormal transports in the Member States in a reliable, comprehensive, and interactive manner, in order to provide all the requested information needed for particular transport permits and the contact data for all relevant authorities.

5.3.2.3 What is the mission?

Users of the services will be able to check
- if special permits are needed;
- if special requirements have to be fulfilled;
- which authorities are involved; and
- whether online applications are available and the corresponding links to the national application procedures.

The service will provide the necessary information and procedures for the communication between the involved authorities and the target group. The target group consists of
- manufacturers producing the product;
- consignors presenting the goods for transport;

— forwarding agencies organising the entire transport;
— shipping companies involved in the sea/waterway transport;
— hauliers/carriers carrying out the transports passing through several countries; and
— consignees receiving the product.

5.3.2.4 Distinctiveness to other ITS-services

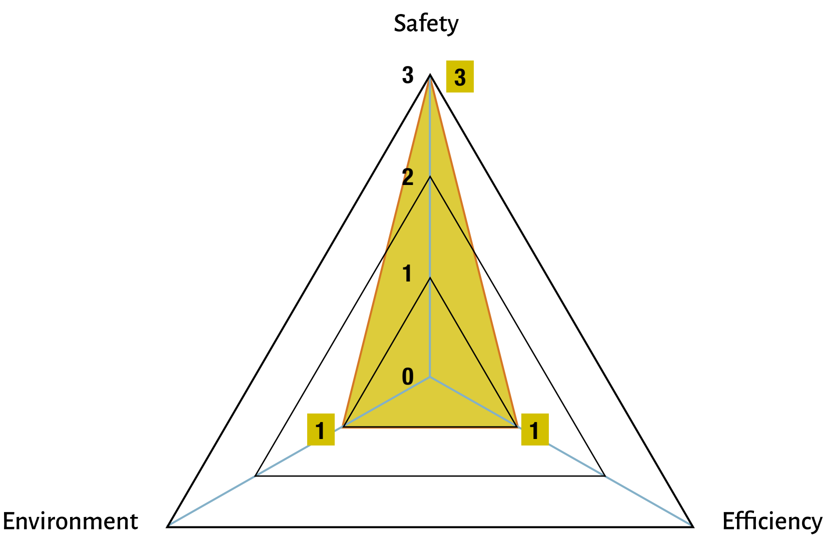
As “Access to abnormal goods transport regulations” is an information service related to transport regulations it cannot be compared with the other TTIS , TMS and F&L services, which are related to the road network and road using and travelling conditions.

5.3.2.5 Contribution to overarching European ITS objectives

5.3.2.5.1 ITS service radar

The graph below provides a quantification of the added value of the “Access to Abnormal Goods Transport Regulations” service regarding safety, efficiency and the environment. The applied scales for the service radar of this service are based mainly on expert view, as the available information in literature is limited.

Figure 102: **Service radar “Access to Abnormal Goods Transport Regulations”**



5.3.2.5.2 Safety

The information on the requirement of special permits is a basic foundation of transports. The prescribed route provided will be safe to accommodate transport of abnormal goods and will prevent or at least provide advance notice of potential problematic spots. Good preparation of one’s transportation route prevents not only inconveniences with authorities but also lowers stress levels, a factor that positively contributes to the reduction of accident risk.

The intended service is going to provide all information needed for hauliers for a smooth transportation process concerning legal authorities and the prescribed routes.

5.3.2.5.3 Environmental impact

The provided information related to application processes for getting permits leads to optimised planning of transportation routes. In addition the application process partly includes prescribed routes. These routes are planned to be network efficient. Optimised traffic flow decreases CO_2 emission. However, the overall positive impact on the environment is assessed as limited.

5.3.2.5.4 Network efficiency

The information on the requirement of special permits partly leads to prescribed routes by the authorities. They are optimised routes and guide drivers through traffic. Particular areas can be avoided and traffic flow can be improved.

5.3.3 Harmonization requirements and advice

5.3.3.1 ITS service definition

Access to abnormal goods transport regulations is an information service where the applicant gets country-specific information on the vehicle regulations and permit application procedures, contact persons, and guidelines for completing application forms for abnormal transports.

This service provides a general access to the main information and procedures regarding a specific abnormal transport, homogenised for all Member States, in a language understandable to the trucker/applicant (English and the respective national languages), and in a timeframe acceptable for modern logistics, supplying a direct link to the already existing different National web platforms.

In this service, both the necessary information and the contact details for the relevant authorities are easily accessible.

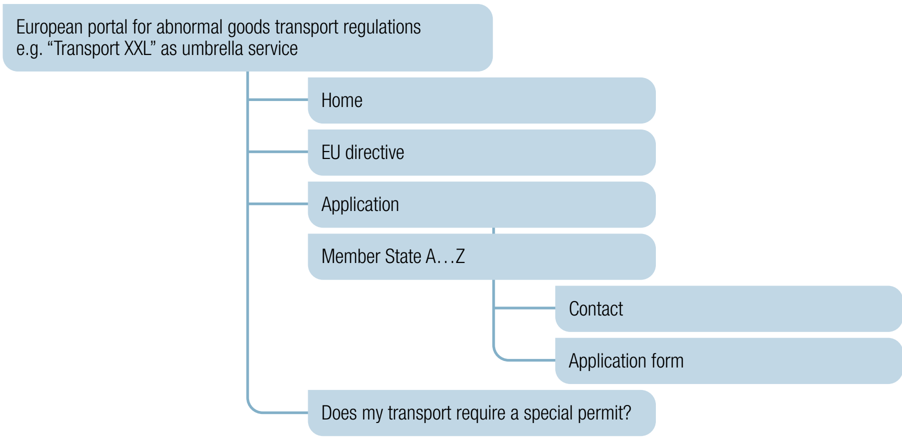
It is planned to build an umbrella that combines all national services. One possible way for an umbrella is the web service TransportXXL. As this project gathers around several countries using the steps developed for this service description to find and implement new participants, it offers very good knowledge about and conditions to handle the development as a comprehensive web service.

5.3.3.2 Functional requirements and advice

This chapter presents the website structure of the umbrella service for abnormal transports, which enables the user to gain a general overview of the topic, 'abnormal transports' and enquire about detailed information for each country.

In the course of its implementation, this service may require additional levels, such as, for example, specific rules regarding escort vehicles inside a Member State. To make the navigation of the website easier, graphical interfaces such as maps will be used.

Figure 103: **Sitemap draft**



The section, 'Home', welcomes the user in the local language (determined via user agent detection) and gives him an introduction to the content of this website. Under the headline 'EU rules and regulations for abnormal transports' the EU-level relevant legislation is specified and described as well as the link to National rules (see figure 1 for depicted sections Home and EU directive).

Functional requirements:

- **FR1**: The website **must** provide information on 'EU rules and regulations for abnormal transports'.
- The user gets all the necessary information regarding the application procedure in the section, 'Application' (see Figure 103), which presents the information according to Member States and subdivided into the sections, 'Contact' and 'Application form'. If there are national online application services in place, the application data may be transferred directly to the corresponding system. Otherwise, the data may be transferred to an application form ready for printing or sending. At the very least, the necessary application forms should be linked to the service.
- **FR2**: The website **should** provide information on the question: 'Does my transport need a special permit?
- In the section 'Does my transport require a special permit?' a query asks the user to submit measurement and weight information to be passed on to the countries of a transport. This data will be compared (by query) to the national regulations of the chosen countries. As an output, the user receives a response explaining whether the transport falls into the category of 'abnormal transport' or not.
- **FR3**: The website **must** provide information on the question: 'How to apply for a special permit?'
- The service must explain the formal procedure. Application forms can be offered for download. If an online application system exists, the link to this service should be provided. A guide through the application process is recommended. All these services can be provided on the national website and be made available by an external link.

Functional advice:

- The service will also feature a search engine. This engine searches the website for the keywords entered by the user. The national project partners are going to be listed in the section 'Imprint and Terms of Use' (or similar), so that users can contact them if they have any further questions.

The service provides information about abnormal transports in the Member States participating in the service provision. The responsibilities fall under three main scopes:
— the technical support of the web based service;
— the accuracy and topicality of the information and links; and
— the accuracy of translations.

Technical support of a web service is a common task of a webmaster. The webmaster, being responsible for the technical support of the umbrella service, cooperates with the webmasters responsible for the services in the participating Member States. The accuracy and topicality of the information provided by the service and the corresponding translations are overseen by a group of experts which consists of one representative from each Member State whose rules and regulations are rendered by the service. These experts are representatives from authorities, road administrations and road operators. Every participating Member State has to appoint one representative for the expert group. This representative is the expert group's contact to the Member States and vice versa. In addition, the expert group is supervised by a corresponding manager who coordinates the teamwork. This position will be continuously assumed by a common service provider.

For a comprehensive platform it should be strived for the transformation of an information portal to a transaction portal.

5.3.3.3 Organisational Requirements

Organisational requirements:
Each participating Member State has to contribute monetary funding if the service is to be launched. The funding form will then be clarified and communicated.

In order to realise this service, resources should be made available for
— **OR1**: Resources and organisations **should** be made available for operating appropriate services as mentioned in chapter 5.3.2.3 in an integrated manner.
— **OR2:** Resources and organisations **should** be made available for the development of a common umbrella for these services.

The nomination of a coordinator will be useful during the development of the umbrella service.

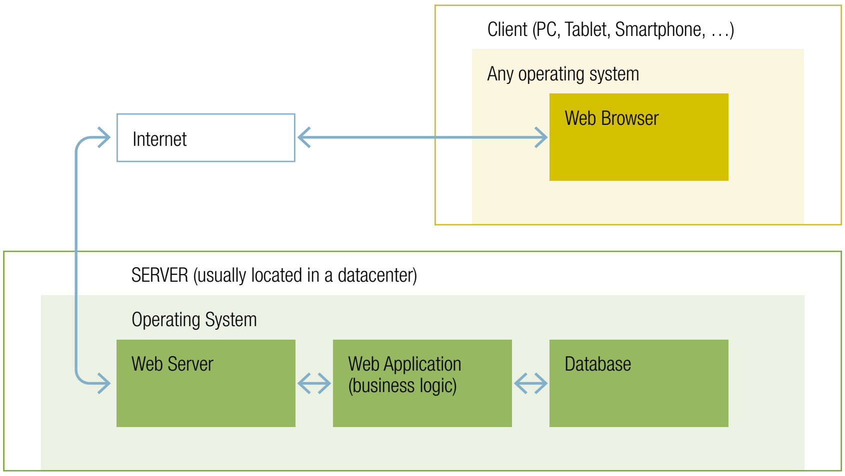
There are other special requirements for Member States participating in provision of this service:
— **OR3**: One contact person for the participating Member State **must** be available for guaranteeing the websites' accuracy and topicality.
— **OR4**: Regular quality improvement loops **should** be established in which user feedback is integrated and the quality of the service can constantly be improved.
— **OR5** Update processes **must** be defined and implemented so that the offered information is always up to date.
— **OR6**: Resources **should** be made available for dissemination and promotion activities for the service.

5.3.3.4 ICT Infrastructure requirements

Technical advice:
— As an ICT infrastructure, a web-based solution complies best with the requirements. A web service can be used to develop an interactive and secure access to databases and services

containing information regarding national regulations and permit application procedures. The general structure of a web service is shown below:

Figure 104: **General structure of a web service**



The umbrella service incorporates existing services regarding abnormal transports. The hard- and software should be adaptable and flexible to further developments and expansions. The update and validation of the data will be conducted online with a specific content management system in connection with the concerted and documented processes defined by one responsible manager. This person in charge will be supported by a working group of national experts from each participating country.

Exchange of data:
In order to identify the requirements of a stable, safe, and sustainable ICT infrastructure, a qualified collection of proven, tested, and comparable existing services (e.g. services introduced as part of implementation of the services directive) will be compiled. Based on this, participating countries must identify hard- and software requirements from these existing services that may also be suitable or applicable to the umbrella service.

The technical requirements for the implementation of an information service for a new country will be quite low, requiring only the relevant regulations and specifications for the new country, as the existing platform will be able to handle these requests.

Technical requirement:
A bilateral information and communication system with a uniform data language enables the participants of the web service to communicate changes of national legislation more easy and convenient. In order to support future developments and services a data model like DATEX II as a language for traffic information, describing all traffic items, their condition and linkage, is recommended.

— **TR1:** A DATEX II data model **may** be used to exchange data.

5.3.3.5 Common Look & Feel requirements

The user will experience a common look and feel of the Internet-based service. 'Common look and feel' means that the umbrella service will have a consistent appearance for the sections corresponding to each participating Member State. The requirements for abnormal transport approvals work under the same principle for each country, so that the user eventually becomes acquainted with the information structure. This only applies to new platforms. Already existing platforms will not have to change their web interface.

The prerequisite for the uniform interface is a common structure on the pages of the several states and direct links to respective approval authorities.

The following steps are required to launch the web service, 'Access to abnormal goods transport regulations' (please refer to the supplementary Part B for supporting forms and tables):

Common look & feel requirements:

— **CL&FR1:** The website **must** provide a description of the services in the local language for the 'Home' section.
— **CL&FR2:** The website **must** provide the section, 'EU rules and regulations' in the local language and in English in order to provide information on procedures in individual EU states.
— **CL&FR3:** The website **must** provide a table containing relevant dimensions[44] as input for the database in the section, 'Does my transport need a special permit?'
— **CL&FR4:** The website **must** provide a general description of the national application procedures, including a link to national application forms, relevant contact information for the application procedure and any additional documents a country would like to make available for download purposes. This information **must** be provided in English and the local language.
— **CL&FR5:** The website **must** provide a translation of the websites' general text highlights describing the web service for users in the local language.

After providing the webmaster with the above texts, translations, and tables, the service will be implemented in the up-and-running system, e.g. 'Transport XXL'. The newly integrated country will then be able to access the relevant part of the CMS. After a certain period of testing, the implemented data would go live.

5.3.3.6 Level of Service Definition

5.3.3.6.1 Level of Service Criteria: Provision

The levels are arranged according to their benefit for the user. Service level A stands for the minimum service available and service level three for the highest user benefit.

— **Service level A: National (Internet-based) Service**
All necessary information about relevant rules and regulations on abnormal goods transports will be provided in the local language on the national website in each EU-Member State participating in the provision of the service. Application forms will be available in the national language.

— **Service level B: National Service in English and the Local Language**
All necessary information on the relevant rules and regulations on abnormal goods transports will be provided in the local and international (i.e. English) languages on the website in each

44 Dimensions are measures (height, length, width and overhang) and weights including axle loads.

participating Member State. Application forms will be available in both languages.

— **Service level C: National Service Connected to the European Portal**
All necessary information on the relevant rules and regulations on abnormal goods transports will be provided in the local and international (i.e. English) languages on the website of the participating Member State connected to the other Member States. Application forms will be available in both languages.

For the provision of a service there are three main criteria:

— **LoSC1:** Do you provide information regarding restrictions and regulations for abnormal transports on an Internet platform in your local language?
— **LoSC2:** Do you provide information regarding restrictions and regulations for abnormal transports on an Internet platform in English?
— **LoSC3:** Is this information service connected to a European portal?

5.3.3.6.2 Level of Service Criteria: Query and Application

In addition, the level of service may also be extended by a query and/or an application.

Using a query, the user will be able to check whether his transport is subject to special requirements and/or permissions or not. To do so, he must enter all relevant facts (e. g. measurements and weights) regarding his transport.

An online application and, if technically possible, the issued permission may be provided in a standardised form for related participating countries. Data already entered in the query may be transferred to the linked national services.

For the provision of a query there is one main criteria:

— **LoSC4:** Is it possible to make a query on whether the transport is subject to special requirements and needs specific permissions?

For the provision of an online application there is one main criteria:

— **LoSC5:** Is the query connected to an online application?

Table 46 gives the Level of Service recommendations for the Abnormal Goods Transport Regulations service. The background of this concept is descripted in chapter 2.6.

Table 45: **Level of Service recommendations for Abnormal Goods Transport Regulations**

Levels of Service criteria table: Abnormal Goods Transport Regulations			
Core Criteria	**A**	**B**	**C**
Provision	National Information service	+ Provision in English	+ Connection to European Portal
Query	Query available		
Online Application	National Online Application available		

5.3.3.6.3 Level of Service Criteria related to Operating Environment

The levels of service are applicable for all operating environments.

6

Annex A: Deployment References

6 Annex A: Deployment References (see separate document)

The “deployment references” annex contains the full set of the approximately 100 filled templates collected, containing information from ITS deployments mainly coming from the CEF ITS Corridors, with the aim to provide the user with practical examples in the implementation of each service, as well as important information for the planning and implementation process, such as lessons learnt and observed benefits.

Due to its length, Annex A is provided as a separate document.

7
Annex B: Compliance checklists

7 Annex B: Compliance checklists

7.1 TTIS - Traffic & Travel Information Services

7.1.1 TTIS-01 Forecast and Real-time Event Information

7.1.1.1 Compliance Checklist "must"

#	Requirement	Fulfilled?		If no – quote of insurmountable reasons
		Yes	No	
Functional requirements				
FR1	Functional decomposition into sub-functions with the provision of interfaces **must** be carried out to enable interoperability in those cases that the service is provided by more than one organisation.			
FR3	Source, scope and quality (based on a quality model to be defined) of data provided by content owners[45] to content providers **must** be defined by the partners and **must** be part of data interface description.			
Organisational requirements				
OR1	The organisational and operational structure of the service as well as the role of each public organisation/body and its exact responsibility and task in the chain **must** be compliant with the National Access Points across Europe, within the scope of the implementation of the delegated acts adopted under Directive 2010/40/EU.			
OR2	All necessary organisational aspects for successful implementation of a "Forecast and Real-time Event Information Service" **must** be documented and agreed by all involved parties/ partners to secure the cooperation.			
OR3	All necessary collaboration processes/ workflows and interfaces **must** be described.			

45 Definition and description of the key actors: see 3.1.4

Interface requirements				
IFR1a	If the Forecast and Real-time Event Information service provides data of one or more of the categories listed below, it **must** provide interface 1 (see Figure 21) coded information following the Delegated Regulation (EU) 886/2013 (SRTI) and as specified in the Document "Safety related message sets – Selection of DATEX II Codes, DENM Event Types, TPEG2-TEC Causes and TMC Events for EC high level Categories". — (a) temporary slippery road — (b) animal, people, obstacles, debris on the road — (c) unprotected accident area — (d) short-term road works — (e) reduced visibility — (f) wrong-way driver — (g) unmanaged blockage of a road — (h) exceptional weather conditions.			
IFR2a	If interface 2 is implemented, the Forecast and Real-time Event Information service **must** provide at interface 2 (see Figure 21) C-ITS coded real-time information on the event categories required in Delegated Regulation 886/2013 (SRTI), including the location of the following elements: — temporarily slippery road — animal, people, obstacles, debris on the road — unprotected accident area — road works — wrong-way driver — unmanaged blockage of a road — reduced visibility — exceptional weather conditions			
IFR1b	If the Forecast and Real-time Event Information service provides data of one or more of the categories listed below, it **must** provide at interface 1 (see Figure 21) coded information following the Delegated Regulation (EU) 2015/962 (RTTI). — (a) road closures — (b) lane closures — (c) bridge closures — (e) roadworks — (f) accidents and incidents — (i) poor road conditions — (p) weather conditions affecting road surface and visibility			

Common look & feel requirements				
none				
Information provision standards				
IPS1a	If a service for Forecast and Real-time Event Information is implemented at interface 1, Safety Related Traffic Information (see IFR1a) **must** be profiled based on EN 16157-3:2019 using the DATEX II Recommended Service Profile for Safety Related Traffic Information.			
IPS1b	If a service for Forecast and Real-time Event Information is implemented at interface 1, Real-time Traffic Information (see IFR1b) **must** be profiled based on EN 16153 using the DATEX II Recommended Service Profiles for Real-time Traffic Information or any international machine-readable format fully compatible and interoperable with DATEX II.			
IPS2b	If interface 2 is implemented, Real-time Related Traffic Information (see IFR2b) **must** be provided based on ETSI EN 302 637-2 using the C-ROADS C-ITS Message Profiles for the Hazardous Location Notification and Road Works Warning services and the use cases AZ, UBR, WCW as defined in the C-ROADS Common C-ITS Service and Use Case Definitions.			
Level of Service requirements				
None				

7.1.1.2 Compliance checklist "should"

#	Requirement	Fulfilled?		If no – explanation of deviation
		Yes	No	
Functional requirements				
FR2	Beneath real-time data also historic data **should** be used to generate event predictions.			
FR4	The quality of the data **should** be in line with the Quality Package defined in EU-EIP Activity 4.1.			

FR5	Beneath the means of information provision (information channels and end user devices), where applicable the area (territory) and locations of information dissemination **should** be defined in relation to the media used.			
Organisational requirements				
OR4	The information provision **should** be in accordance with any management plans (TMP, see TMS-07) which are in operation of the road authorities or traffic management centres.			
Interface requirements				
IFR3a	When relevant, the Forecast and Real-time Event Information service **should** collect at interface 3 (see Figure 21) C-ITS coded Information from C-ITS equipped end user devices/vehicles relevant to this ITS Core service such as travel speed, direction, current location of a vehicle.			
IFR2b	If interface 2 is implemented , the Forecast and Real-time Event Information service **should** provide at interface 2 (see Figure 21) C-ITS coded real-time information on the event categories required in Delegated Regulation 2015/962 (RRTI) and listed below, in detail specified: ▪ road closures ▪ lane closures ▪ roadworks ▪ accidents and incidents ▪ weather conditions affecting road surface and visibility			
IFR3b	When relevant, the Forecast and Real-time Event Information service **should** collect at interface 3 (see Figure 21) C-ITS coded real-time information from C-ITS equipped end user devices/vehicles relevant to this ITS Core service such as travel speed, direction, current location of a vehicle.			
Common look & feel requirements				
CL&FR1	Information for the end user **should** always be consistent whatever media or end user device is used.			

CL&FR2	The display of signs/pictograms on VMS or other end-user devices **should** be in accordance with prevailing national road codes and: — Member States which ratified the Vienna Convention MUST respect the Vienna Convention and the European agreement supplementing the convention (1st May 1971) and SHOULD consider the Consolidated Resolution on Road Signs and Signals (R.E.2). — Member States which did not ratify the Vienna Convention SHOULD follow the Vienna Convention and also consider the R.E.2.			
ICT Infrastructure requirements				
none				
Required standards and specifications				
IPS2a	If interface 2 is implemented, Safety Related Traffic Information (see IFR2a) **should** be provided based on ETSI EN 302 637-2 using the C-ROADS C-ITS Message Profiles for the Hazardous Location Notification and Road Works Warning services and the use cases TSR, APR, OR, AZ, SV, WCW, AWWD, UBR as defined in the "C-ROADS Common C-ITS Service and Use Case Definitions".			
IPS3a	When relevant, the Safety Related Traffic Information (see IFR3a) **should** be collected from C-ITS equipped vehicles based on ETSI EN 302 637-2 using the CAR 2 CAR Communication Consortium Basic System Profile.			
IPS3b	When relevant, the Probe Vehicle Data (microscopic traffic situation) information (see IFR3) such as travel speed, direction, current location of a vehicle **should** be collected, which is profiled based on ETSI EN 302 637-2 using the CAR2CAR Communication Consortium Basic System Profile.			
Level of Service requirements				
LoSR1	In the case that pre-deployment surveys / evaluations provide the necessary evidence to proceed with the deployment of the ITS-service "Forecast and Real-time Event Information", the minimum and optimum LoS **should** respect the following Level of Service to Operating Environment mapping table. (Table 17)			

7.1.1.3 Compliance checklist "may"

#	Requirement	Fulfilled?		If yes – remarks
		Yes	No	
Functional requirements				
none				
Organisational requirements				
none				
ICT Infrastructure requirements				
none				
Common Look & Feel requirements				
none				
Level of service requirements				
none				

7.1.2 TTIS-02 Traffic Condition and Travel Time Information

7.1.2.1 Compliance Checklist "must"

#	Requirement	Fulfilled?		If no – quote of insurmountable reasons
		Yes	No	
Functional requirements				
FR1	Functional decomposition into sub-functions with the provision of interfaces **must** be carried out to enable interoperability in those cases that the service is provided by more than one organisation			
FR2	All collected and provided data elements **must** contain: — where applicable, location code(s) — a time stamp The geographical basis of the location code should be left to the road operator to define, anyway the model of information provision to other organisations must respect DATEX II location reference and time stamp model.			
FR4	Source, scope and quality of data provided by content owners to content providers **must** be defined by the partners and must be part of data interface description.			

Organisational requirements				
OR1	The organisational and operational structure of the service, as well as the role of each organisation/body and its exact roles and tasks in the value chain **must** be compliant with the National Access Points across Europe, within the scope of the implementation of the delegated acts adopted under Directive 2010/40/EU.			
OR2	All necessary organisational aspects **must** be documented and agreed by all involved parties/ partners to ensure cooperation.			
OR3	All necessary collaboration processes/ workflows and interfaces **must** be described and documented.			
Interface requirements				
IFR1	If the Traffic Condition and Travel Time service provides data of one or more of the categories listed below at interface 1 (see Figure 23), it **must** provide coded information including the following elements: — Location for the traffic conditions and/or travel times — Traffic status (Level of Service), and if applicable relevant types of vehicles — Current travel times, if applicable also for free flow, and if applicable relevant types of vehicles — Relevant Point of time			
IFR2	If interface 2 is implemented, the Traffic Condition and Travel Time Information Service **must** provide at interface 2 (see Figure 23) C-ITS coded information on the Traffic Condition and Travel Time including the following elements: — the setting of a road sign (what is shown in the sign) — the location/relevant area of the sign			
Common look & feel requirements				
none				

Information provision standards				
IPS1	If the Traffic Condition and Travel Time service provides Traffic Condition and Travel Time information (see IFR1), it **must** be profiled based on CEN/TS 16157-5:2020 using the DATEX II Recommended Service Profile for Traffic Condition and Travel Time. The use of the PredefinedLocationsPublication is recommended. For calculated travel time information, the ElaboratedDataPublication is recommended to be used, otherwise the MeasurementSiteTablePublication.			
IPS2	If interface 2 is implemented, Traffic Condition and Travel Time information (see IFR2) **must** be profiled in an IVIM (Infrastructure to Vehicle Information Message) based on ISO 19321 using the C-ROADS C-ITS Message Profiles for the IVS-TS use case.			
Level of Service requirements				
None				

7.1.2.2 Compliance checklist "should"

#	Requirement	Fulfilled?		If no – explanation of deviation
		Yes	No	
Functional requirements				
FR3	Besides real-time data also historic data **should** be used to generate traffic condition and real-time predictions.			
FR5	The quality of the data **should** be defined and the travel time information quality should be in line with the relevant quality model.			
FR6	All stakeholders and partners involved in the value chain of a Traffic Condition and Travel Time Information service **should** formally agree and accept under which conditions information can be disseminated to the end user, for example: — without any restrictions — tied to the conditions of an appropriate partnership agreement			

FR7	Underlying the information provision (information channels and end user devices), where applicable, the area (territory) and locations of information dissemination **should** be defined in relation to the media used.			
Organisational requirements				
none				
Interface requirements				
IFR3	When relevant, the Traffic Condition and Travel Time Information Service **should** collect at interface 3 (see Figure 23) C-ITS coded information on Probe Vehicle Data (microscopic traffic situation) relevant to this ITS Core service, such as travel speed, direction, current location of a vehicle.			
Common look & feel requirements				
CL&FR1	The display of signs/pictograms on VMS or other end-user devices **should** be in accordance with prevailing national road codes and: — Member States which ratified the Vienna Convention MUST respect the Vienna Convention and the European agreement supplementing the convention (1st May 1971) and SHOULD consider the Consolidated Resolution on Road Signs and Signals (R.E.2). — Member States which did not ratify the Vienna Convention SHOULD follow the Vienna Convention and also consider the R.E.2. It is up to the deploying road operator to ensure that physical road signs are well and widely understood by the road users.			
CL&FR3	The display of travel times and delay times on VMS or other end-user devices (websites, navigation systems…) **should** respect the following format: <XX> min.			
CL&FR4	Concerning VMS, the travel time may be complementary with "(+ YY)" to denote the delay in addition to normal travel time. The YY **should** represent the additional time due to perturbation, included in the <XX> part.			
CL&FR5	It **should** always be indicated for which location (intersection, exit, city …) the travel time displayed is valid.			
ICT Infrastructure requirements				
none				

Required standards and specifications				
IPS3	When relevant, the Probe Vehicle Data (microscopic traffic situation) information (see IFR3) **should** be collected, which is profiled based on ETSI EN 302 637-2 using the CAR2CAR Communication Consortium Basic System Profile.			
Level of Service requirements				
LoSR1	In the case that pre-deployment surveys / evaluations provide the necessary evidence to proceed with the deployment of the ITS-service "Traffic Condition and Travel Time Information", the minimum and optimum LoS **should** respect the following Level of Service to Operating Environment mapping table. (Table 20)			

7.1.2.3 Compliance checklist "may"

#	Requirement	Fulfilled?		If yes – remarks
		Yes	No	
Functional requirements				
none				
Organisational requirements				
none				
ICT Infrastructure requirements				
none				
Common Look & Feel requirements				
none				
Level of service requirements				
none				

7.1.3 TTIS-03 Speed Limit Information

7.1.3.1 Compliance Checklist "must"

#	Requirement	Fulfilled?		If no – quote of insurmountable reasons
		Yes	No	
Functional requirements				
FR1	Source, scope and quality of speed limit information provided by content owners to content providers **must** both be defined and part of data interface descriptions.			
FR2	Speed Limit Information collected and information provided by content owners to content providers **must** be based upon both a consistent geographic reference model and a time validity model, which both **must** be agreed among parties participating in the service and part of data interface descriptions.			
Organisational requirements				
OR1	The organisational and operational structure of the service as well as the role of each public organisation/body and its exact responsibility and task in the chain **must** be compliant with the National Access Points across Europe, within the scope of the implementation of the delegated acts adopted under Directive 2010/40/EU.			
OR2	All necessary organisational aspects for successful implementation of a "Speed Limit Information Service" **must** be documented and agreed by all involved parties/partners to establish the cooperation.			
OR3	All necessary collaboration processes/ workflows and interfaces **must** be described.			
Interface requirements				
IFR1	If the Speed Limit service implemented provides data listed below at interface 1 (see Figure 24), it **must** provide coded information on the current speed limit including the following elements: — The maximum Speed Limit — Location (section) of the Speed Limit — Where necessary, the type of vehicle concerned by the Speed Limit			

IFR2	If interface 2 is implemented, the Speed Limit Information Service **must** provide at interface 2 (see Figure 24) C-ITS coded information on the current speed limit including the following elements: — the setting of a (variable) Speed Limit sign (gantry) — the location of the sign (gantry) and the stretch of road to the next sign (gantry) — where necessary, the type of vehicle concerned by the Speed Limit (text)			
Common look & feel requirements				
CL&FR1	If a Speed Limit service is implemented at interface 1, the Speed Limit information (see IFR1) **must** be profiled based on EN 16157-3:2019 using the DATEX II Recommended Service Profile for Speed Limits.			
Information provision standards				
IPS1	If a Speed Limit service is implemented at interface 1, the Speed Limit information (see IFR1) **must** be profiled based on EN 16157-3:2019 using the DATEX II Recommended Service Profile for Speed Limits.			
IPS2	If interface 2 is implemented, Speed Limit information (see IFR2) **must** be profiled in an IVIM (Infrastructure to Vehicle Information Message) based on ISO 19321 using the C-ROADS C-ITS Message Profiles for the In-Vehicle Signage service, specifically the Traffic Sign use case as defined in the C-ROADS Common C-ITS Service and Use Case Definitions.			
Level of Service requirements				
None				

7.1.3.2 Compliance checklist "should"

#	Requirement	Fulfilled? Yes	No	If no – explanation of deviation
Functional requirements				
FR3	If a speed limit information service involves road operators and service providers, information exchange platform systems between road operators and service providers **should** be implemented to update the databases.			
FR4	The frequency of the updates of the speed limit databases **should** be agreed (and published) and ensured by parties participating in the service.			
FR5	A feedback loop between service providers and the road operators **should** be put in place to ensure correct data provision and integration in the speed limits databases.			
Organisational requirements				
none				
Interface requirements				
IFR3	When relevant, the Speed Limit Information service **should** collect at interface 3 (see Figure 24) C¬ITS coded information on Probe Vehicle Data (microscopic traffic situation) such as travel speed, direction, current location of a vehicle relevant to this ITS Core service.			
Common look & feel requirements				
CL&FR2	Specific complementary signing of speed limit signage **should** be language independent.			
ICT Infrastructure requirements				
none				
Required standards and specifications				
IPS3	When relevant, the Probe Vehicle Data (microscopic traffic situation) information (see IFR3) **should** be collected, which is profiled based on ETSI EN 302 637-2 using the CAR2CAR Communication Consortium Basic System Profile.			

Level of Service requirements				
LoSR1	In case that pre-deployment surveys/ evaluations provide the necessary evidence to proceed with the deployment of the "Speed limit Information service", the minimum and optimum LoS **should** respect the following Level of Service to Operating Environment mapping table.			

7.1.3.3 Compliance checklist "may"

#	Requirement	Fulfilled? Yes	No	If yes – remarks
Functional requirements				
none				
Organisational requirements				
none				
ICT Infrastructure requirements				
none				
Common Look & Feel requirements				
none				
Level of service requirements				
none				

7.1.4 TTIS-04 Road Weather Information

7.1.4.1 Compliance Checklist "must"

#	Requirement	Fulfilled? Yes	Fulfilled? No	If no – quote of insurmountable reasons
Functional requirements				
none				
Organisational requirements				
OR1	Public administrations **must** act according to the assigned scope of their activities, which is normally regulated by law or similar regulations. In the field of the road weather information service provision, it has therefore to be distinguished between mandatory services and non-mandatory (voluntary) ones according to national laws.			
OR2	If a guarantee is needed that a service is provided in a single country, a regulation **must** be issued.			
Interface requirements				
IFR1a	If a service for Road Weather Information is implemented at interface 1 (Figure 26) and it provides data on one or more of the categories listed below, ▪ (a) temporary slippery road ▪ (e) reduced visibility ▪ (h) exceptional weather conditions the service **must** provide coded information following the Delegated Regulation (EU) 886/2013 (SRTI) and as specified in the Document "Safety related message sets – Selection of DATEX II Codes, DENM Event Types, TPEG2-TEC Causes and TMC Events for EC high level Categories" including the following elements: ▪ location of the event or the condition ▪ the category of event or condition (short description of it) ▪ driving behaviour advice, where appropriate			

IFR1b	If a service for Road Weather Information is implemented at interface 1 (see Figure 26) and it provides data on (p) weather conditions affecting road surface and visibility, the service **must** provide coded information following the Delegated Regulation (EU) 2015/962 (RTTI) including the following elements: ▪ location of the event or the condition ▪ the category of event or condition (short description of it) ▪ driving behaviour advice, where appropriate			
IFR2	— If interface 2 is implemented, the Road Weather Information Service **must** provide at interface 2 (see Figure 26) Weather information coded in C-ITS messages including the following elements: ▪ Location of the weather warning area ▪ Location of slippery roads ▪ Relevant road signs regarding the weather situation			
Common look & feel requirements				
none				
Information provision standards				
IPS1	If the Road Weather Information service provides Road Weather Information at interface 1 (see IFR1), it **must** be profiled based on EN 16157-5:2020 using the DATEX II Recommended Service Profile for Road Weather information.			
Level of Service requirements				
None				

7.1.4.2 Compliance checklist "should"

#	Requirement	Fulfilled? Yes	No	If no – explanation of deviation
Functional requirements				
FR1	The Road Weather Information service **should** support road maintenance and infrastructure management (expert service) and **should** be able to collect process and disseminate weather information for travellers (end user service).			
FR2	The Road Weather Information **should** provide information in the native language(s) at the output location, and from a user selected choice of other appropriate foreign languages, when applicable.			
FR3	The Graphical User Interface (GUI) **should** provide information using graphical representation or text. Graphical form **should** include the use of maps as well as text.			
Organisational requirements				
none				
Interface requirements				
IFR3	When relevant, the Weather Information Service **should** collect at interface 3 (see Figure 26) C-ITS coded Probe Vehicle Data information (microscopic traffic situation such as travel speed, travel direction, steering position, current location of a vehicle, traction information) relevant to this ITS Core service.			

46 Level 1 could be merged with Level 2 to communicate only three levels towards the end users
47 Level 1 could be merged with Level 2 to communicate only three levels towards the end users
48 Level 1 could be merged with Level 2 to communicate only three levels towards the end users
49 Level 1 could be merged with Level 2 to communicate only three levels towards the end users

Common look & feel requirements				
CL&FR1	Three or four levels **should** be indicated based on seriousness/ probability of the event when providing a web-based information service. It is recommended that the levels are defined based on local circumstances. However, the message for the drivers should be clearly communicated and be the same across Europe — Level 0 (normal conditions) - message for drivers: be prepared — Level 1 (moderate conditions) - message for drivers: drive carefully[46] — Level 2 (strong conditions)- message for drivers: special attention needed[47] — Level 3 (extreme conditions) - message for drivers: take action (in accordance with regulations from each Member State, regarding the type of extreme condition of weather and what means "extreme weather" in that country)			
CL&FR2	A graphical representation **should** use a pictogram + a coloured bar to indicate the level of seriousness/ probability when providing a web-based information service. — Level 0 (normal conditions) - green — Level 1 (moderate conditions) - yellow[48] — Level 2 (strong conditions)- orange[49]			
CL&FR3	As content for pictograms the defined set of content for pictograms **should** be used when providing a web-based information service will be aligned with the pictograms regarding weather information from Vienna Convention. It is recommended that the limits are defined based on local circumstances.			
ICT Infrastructure requirements				
none				

Required standards and specifications				
IPS2	If interface 2 is implemented, Weather information regarding the in-vehicle signage of road signs (see IFR2) **should** be profiled in an IVIM (Infrastructure to Vehicle Information Message) based on ISO 19321 using the C-ROADS C-ITS Message Profiles for the In-Vehicle Signage service. Additionally, all other Weather information (see IFR2) should be profiled in a DENM (Decentralized Environmental Notification Message) based on ETSI EN 302 637-2 using the C-ROADS C-ITS Message Profiles for the Hazardous Location Notification service and the Use-Cases Weather Condition Warning (WCW) and Temporarily Slippery Road (TSR), as defined in the C-ROADS Common C-ITS Service and Use Case Definitions.			
IPS3	When relevant, the Probe Vehicle Data (microscopic traffic situation) information (see IFR3) **should** be collected, which is profiled based on ETSI EN 302 637-2 using the CAR2CAR Communication Consortium Basic System Profile.			
Level of Service requirements				
none				

7.1.4.3 Compliance checklist "may"

#	Requirement	Fulfilled? Yes	No	If yes – remarks
Functional requirements				
none				
Organisational requirements				
none				
ICT Infrastructure requirements				
none				
Common Look & Feel requirements				
none				
Level of service requirements				
none				

7.1.5 TTIS-05 Multimodal Travel Information Services

7.1.5.1 Compliance Checklist "must"

#	Requirement	Fulfilled? Yes	No	If no – quote of insurmountable reasons
Functional requirements				
FR1	Multimodal Travel Information **must** be based on a common or at least interoperable geographical reference model to be able to integrate different data sources which most likely use different location referencing methodologies and thus come to a common location referencing denominator.			
Organisational requirements				
OR7	Multimodal travel information service providers **must** take into consideration the Delegated Regulation on MMTIS (2017/1926) when developing services.			
Interface requirements				
none				
Common look & feel requirements				
none				
Information provision standards				
IPS2	If interface 2 is implemented, the Multimodal Travel Information (see IFR2) **must** be profiled in an IVIM (Infrastructure to Vehicle Information Message) based on ISO 19321 using the C-ROADS C-ITS Message Profiles for the In-Vehicle Signage service.			
Level of Service requirements				
None				

7.1.5.2 Compliance checklist "should"

#	Requirement	Fulfilled? Yes	No	If no – explanation of deviation
Functional requirements				
FR2	Multi-Modal Traveller Information and service platform **should** be based on a harmonised data model for each service feature. Service developer **should** orient the data model on already existing best practices.			

Organisational requirements				
OR2	Business models could be influenced by commercial considerations, which might lead to a preference of specific transport modes/ means or other information content. This is one important reason that multimodal services **should** reflect a comparison of modes/means of transport not biased due to commercial motives.			
OR3	Multimodal services according to A.1, A.2, A.3 and A.4 **should** be free of charge and non-commercial. Advertising respectively financing concepts with participation of the private sector are allowed as far as it is under public control and it does not lead to a preference of any specific transport mode or means of transport.			
OR6	Multimodal service providers **should** take into consideration the ITS directive (2010/40/EU) when developing services.			
OR8	Multimodal travel information service providers, transport operators and transport authorities **should** focus service implementation on the services and according to the timeline provided in the Delegated Regulation on MMTIS (2017/1926).			
Interface requirements				
IFR1	If the Multimodal Travel Information service provides data listed below at interface 1 (see Figure 27), it **should** provide coded information including the following elements. — static travel and traffic data and historic traffic data listed in point 1 of the Annex to the Delegated Regulation 2017/1926 — dynamic travel and traffic data of different transport modes listed in point 2 of the Annex to the Delegated Regulation 2017/1926 — routing / voyage planning results			

IFR2	If interface 2 is implemented, the Multimodal Travel Information Service **should** provide at interface 2 (see Figure 26) Multimodal Travel information coded in C-ITS messages for example the following elements: — road signs, — travel time information, — congestion information, — directions to suitable parking spaces or — modal shift advices to the public transport.			
IFR3	When implemented for C-ITS services, the Multimodal Travel Information Service **should** collect at interface 3 (see Figure 26) C-ITS coded Probe Vehicle Data information such as travel speed, direction, current location of a vehicle (microscopic traffic situation) relevant to this ITS Core service.			
Common look & feel requirements				
CL&FR1	Multimodal services **should** take into consideration the requirements for colour blind and other visually impaired people as far as possible			
CL&FR3	Multimodal services **should** use different colours to indicate the different means of transport in maps.			
CL&FR4	The display of signs/pictograms on VMS or other end-user devices **should** be in accordance with prevailing national road codes and: — Member States which ratified the Vienna Convention MUST respect the Vienna Convention and the European agreement supplementing the convention (1st May 1971) and SHOULD consider the Consolidated Resolution on Road Signs and Signals (R.E.2). — Member States which did not ratify the Vienna Convention SHOULD follow the Vienna Convention and also consider the R.E.2.			
CL&FR6	Icons **should** use internationally understandable designs and avoid country/ region specific designs where possible/ applicable.			
ICT Infrastructure requirements				
TR1	Multimodal travel information services **should** offer at least information for public transport, bicycle transport, car transport and pedestrian.			

Required standards and specifications				
IPS1	**If the** Multimodal Travel Information service provides multimodal traveller information at **interface 1** (see IFR1), it **should** be profiled conform the standards and initiatives listed below best fitting for their purposes. — Interoperable data models and standards for multimodal networks ▪ GDF (just road network) ▪ INSPIRE — Interoperable data formats for dynamic location referencing with the focus for individual transport content: ▪ OpenLR ▪ TPEG-Loc — Interoperable content modelling (data model, format and protocol) with road transport focus for dynamic data: ▪ DATEXII ▪ TPEG — Interoperable content modelling (data model, format and protocol) with public transport focus for dynamic data: ▪ SIRI ▪ NeTEx ▪ Transmodel — Protocol and method to connect routing systems ▪ DELFI ▪ EU-SPIRIT ▪ Open API for Distributed Journey Planning - CEN/TS 17118:2018 — Standardized protocols and methods to transfer map data and additional map information: ▪ TN-ITS specification			
IPS2	If interface 2 is implemented, the Multimodal Travel Information (see IFR2) **must** be profiled in an IVIM (Infrastructure to Vehicle Information Message) based on ISO 19321 using the C-ROADS C-ITS Infrastructure Functions and Specifications for the In-Vehicle Signage service.			
IPS3	When implemented for C-ITS services, the Probe Vehicle Data (microscopic traffic situation) information (see IFR3) **should** be collected, which is profiled based on ETSI EN 302 637-2 using the CAR2CAR Communication Consortium Basic System Profile.			

Level of Service requirements				
none				

7.1.5.3 Compliance checklist "may"

#	Requirement	Fulfilled?		If yes – remarks
		Yes	No	
Functional requirements				
none				
Organisational requirements				
OR1	The Multimodal Travel Information service **may** be organised according to the schemas A.1, A.2, A.3 or A.4 as shown in Figure 20.			
OR5	Public transport operators **may** be obliged by contract to provide their data in a format that is useful and defined by the public authority.			
ICT Infrastructure requirements				
none				
Common Look & Feel requirements				
CL&FR2	Multimodal services **may** use the colours for means of transport route indication as listed above as far as these colours have enough contrast to the map background information.			
CL&FR5	Icons **may** be categorized (e.g. in categories for travel information, public institutions etc.) and **may** follow a common colour scheme.			
CL&FR7	Public transport icons for means of transport and public transport stops/stations **may** follow the local public transport operators design.			
CL&FR8	Multimodal Travel Information services do not necessarily provide a map presentation. They might offer routing information and / or travel information besides maps in textual or a graphical way. This information provision **may** follow already existing services. The presentation of multimodal travel information besides the map presentation **may** follow already existing deployments.			
Level of service requirements				
none				

7.2 TMS - Traffic Management Services

7.2.1 TMS-01 Dynamic Lane Management

7.2.1.1 Compliance Checklist "must"

#	Requirement	Fulfilled?		If no – quote of insurmountable reasons
		Yes	No	
Functional requirements				
FR5	Road clearance monitoring: before applying any dynamic lane management (DLM), it **must** be verified that no car is stopped on the dynamic lane or in lay-bys from where no signs are visible (done by video-cameras and/ or police or alternative technologies where appropriate).			
FR7	Site investigation: local control devices **must** be connected to a traffic control centre. Operators in the traffic control centre **must** have access to an interface to remotely monitor traffic detectors and activate all VMS on the carriageway, managed by the centre itself using where applicable a decision support tool.			
FR8	Safety procedures: procedures **must** exist in order to apply all safety measures (before and during the DLM process). Safeguarding measures in the form of dynamic road markings, closing and guidance facilities can then be launched.			
FR9	Before the lane under control is 'released' for temporary use, it **must** be checked whether the lane concerned is available and safe to use for the corresponding traffic by means of video monitoring, police, traffic officers or alternative technologies as appropriate.			
FR10	Traffic guidance to road users: when implementing a dynamic lane management (DLM) system, the road users **must** be informed about the availability of lanes by using suitable information means such as variable message signs, permanent light signs, multiple-faced signs or prisms or lane lights.			
Organisational requirements				
OR1	The organisational and operational structure of the service, as well as the role of each organisation/body and its tasks, **must** be defined.			

OR2	Appropriate procedures **must** be defined for the activation and deactivation of the dynamic management of lanes.			
Interface requirements				
IFR1	If the Dynamic Lane Management service provides dynamic lane information at interface 1 (see Figure 44) it **must** provide coded information including the following elements: — Type of the dynamic lane management, and, if applicable, the type of constriction — Location of dynamic lane management, if applicable including additional information on effected or restricted lanes and the residual number of lanes — If applicable start time and end time of the dynamic lane management			
IFR2	If interface 2 is implemented, the Dynamic Lane Management service **must** provide at interface 2 (see Figure 44) Dynamic Lane Management information coded in C-ITS messages including the following elements: — the respective road signs for dynamic lane management — respective road signs relevant for the situation			
Common look & feel requirements				
CL&FR2	Normally every VMS **must** display a sign (green arrow, yellow/white deflection arrow, “end of restriction”, red cross or speed limit) over each lane when VMS is in active use. An exception to this is the use of red crosses over “hard shoulder running lanes” or special “rush hour lanes” that are not in use; in those cases there is no need to display any sign on VMS.			
CL&FR3	A yellow/white deflection arrow **must** be displayed before the closure of the lane (red cross) when it was opened before.			
CL&FR4	A yellow/white deflection arrow **must not** point towards a lane that appears closed on the next signal gantry.			
CL&FR5	The road operator **must** close only one lane at a time, if DLM arrangement enables the operation.			
CL&FR6	At the end of the DLM zone, normal allocation of lanes **must** be indicated on VMS display either by a green arrow or by an “end of restriction” sign or maximum allowed “speed limit sign”.			

CL&FR9	On the dedicated tidal lane at least one section of the lane **must** be cancelled to traffic prior to DLM implementation: one on both directions.			
CL&-FR10	VMS series **must** be installed so as to ensure maximum service visibility.			
CL&-FR13	DLM service **must** be activated in accordance with the local signalisation pattern			
ICT Infrastructure requirements				
TR1	Variable message signs for the closure or release of lanes **must** be installed.			
TR2	Vehicle detectors **must** be installed along the main carriageway, providing information on current traffic conditions; in some cases, they are needed to decide whether to activate the DLM process			
TR3	Video surveillance (including CCTV) **must** be implemented for tidal flow, DLM in tunnels and for hard shoulder release.			
TR4	A control centre with competent operational software, visualization systems, reporting and report/system archiving systems **must** be available.			
Information provision standards				
IPS1	If the Dynamic Lane Management service provides dynamic lane information at interface 1 (see IFR1), it **must** be profiled based on EN 16157-3:2019 using the DATEX II Recommended Service Profile for Dynamic Lane Management.			
IPS2	If interface 2 is implemented, Dynamic Lane Management information (see IFR2) **must** be profiled in an IVIM (Infrastructure to Vehicle Information Message) based on ISO 19321 using the C-ROADS C-ITS Message Profiles for the In-Vehicle Signage service, specifically the Traffic Sign Use-Case.			
Level of Service requirements				
None				

7.2.1.2 Compliance checklist "should"

#	Requirement	Fulfilled? Yes	No	If no – explanation of deviation
Functional requirements				
FR1	Dynamic lane management service implementation **should** be carried out the following functional decomposition into sub-functions: — Carry out an advisability study — Prepare the Dynamic lane management implementation — Collect and analyse data transmitted from monitoring systems — Monitoring — Decide the relevant Dynamic lane management implementation strategy to apply — Traffic guidance to road users — Track the decision for assessment use — Evaluate and assess, measure the impacts in order to provide recommendation and improvement (if possible)			
FR3	Physical layout – the following items shall be taken into account: — acceleration and deceleration ramps **should** be long enough to let vehicles have the time to check the carriageway before entering it, without causing queues — enough lay-bys **should** be available to allow vehicles to stop in case of emergency when lanes are allocated (especially for hard shoulder running)			
FR4	Monitoring: infrastructure and control equipment **should** be used to monitor the traffic conditions and regulate traffic flows. Monitoring data collection system (also CCTV) **should** be able to detect real-time vehicle flow and speed.			
FR6	The clearing process **should** take place by controlling lane availability. This can be done for the whole section or in stages. To start the clearing process, particularly with lane safeguarding, a yellow/white lane divert arrow (with or without flashing lights) **should** be used as transition signal, before lane closure signs (red crosses) are used in advance of the incident site.			

Organisational requirements				
none				
Interface requirements				
IFR3	When relevant, the Dynamic Lane Management service **should** collect at interface 3 (see Figure 44) C-ITS coded Probe Vehicle Data information (microscopic traffic situation) relevant to this ITS Core service.			
Common look & feel requirements				
CL&FR1	The display of signs/pictograms on VMS or other end-user devices **should** be in accordance with prevailing national road codes and: — Member States which ratified the Vienna Convention MUST respect the Vienna Convention and the European agreement supplementing the convention (1st May 1971) and SHOULD consider the Consolidated Resolution on Road Signs and Signals (R.E.2). — Member States which did not ratify the Vienna Convention SHOULD follow the Vienna Convention and also consider the R.E.2.			
CL&FR7	When there is a wish to display both a speed limit and a green arrow over the lanes, an additional VMS **should** be used.			
CL&FR8	The distance between 2 VMS series **should** not be too long (suggestion: < 1000m).			
CL& FR11	If lane availability within tunnels is reduced due to planned works or incidents, DLM **should** be activated before the tunnel entrance.			
CL& FR12	Lane allocation **should** remain constant within the tunnel as long as possible.			
ICT Infrastructure requirements				
TR5	All ICT Infrastructure described at technical requirements TR1 TR2 TR3 TR4 **should** be supplied with an uninterruptible power supply or/and an emergency power system to ensure the continuity of service in case the mains electricity power source fails.			
Required standards and specifications				
IPS3	When relevant, the Probe Vehicle Data (microscopic traffic situation) information (see IFR3) **should** be collected, which is profiled based on ETSI EN 302 637-2 using the CAR2CAR Communication Consortium Basic System Profile.			

Level of Service requirements				
LoSR1	In the case that pre-deployment surveys/ evaluations provide the necessary evidence to proceed with the deployment of the ITS-service “Dynamic Lane Management”, the minimum and optimum LoS **should** respect the following Level of Service to Operating Environment mapping table. (Table 31)			

7.2.1.3 Compliance checklist “may”

#	Requirement	Fulfilled?		If yes – remarks
		Yes	No	
Functional requirements				
FR2	An analysis of traffic flows and current and required infrastructure **may** be carried out before implementing the service to define whether it is needed or not, if it will bring benefits to traffic efficiency and if it is feasible			
Organisational requirements				
none				
ICT Infrastructure requirements				
none				
Common Look & Feel requirements				
none				
Level of service requirements				
none				

7.2.2 TMS-02 Variable Speed limits

7.2.2.1 Compliance Checklist "must"

#	Requirement	Fulfilled? Yes	No	If no – quote of insurmountable reasons
Functional requirements				
FR4	The signs **must** display the speed limit that the control system has requested, and functionality **must** be monitored continuously.			
FR9	Collected data **must** be of sufficient quality to provide adequate input in the control system, in some cases this can necessitate the installation of additional roadway sensors. Exceptions: For systems using clock and/or calendar control, sensors are replaced by the system clock. For manually controlled systems at road works, sensors are usually replaced by a keypad (local control unit) or similar. **Note:** Systems may include both manual and automatic functions as well as several types of sensors. This requires well defined hierarchical rules and priorities.			
Organisational requirements				
none				
Interface requirements				
IFR1	The Variable Speed Limit service **must** provide at interface 1 (see Figure 51) information on the current speed limit defined in DATEX II Recommended Service Profile including the mandatory data of following classes: — Common information — Location Referencing information — Road Traffic Data — Situation information — VMS, includes VMS panel information			
IFR2	If interface 2 is implemented the Variable Speed Limit Service **must** provide at interface 2 (see Figure 51) C-ITS coded information relevant to this ITS Core service.			
Common look & feel requirements				
none				

Information provision standards				
IPS1	If a Variable Speed Limit service is implemented at interface 1 (see IFR1), it **must** be profiled based on CEN/EN 16157-3 using the DATEX II Recommended Service Profile for Speed Limits or any international machine-readable format fully compatible and interoperable with DATEX II.			
IPS2	If interface 2 is implemented, Variable Speed Limit information (see IFR2) **must** be profiled in an IVIM (Infrastructure to Vehicle Information Message) based on ISO 19321 using the C-ROADS C-ITS Message Profiles for the In-Vehicle Signage service, specifically the Traffic Sign Use Case.			
SS1	Discontinuous signs (i.e. LED) must follow the European standard EN 12966:2014+A1:2019 or their national counterparts. Continuous signs (retro-reflective, i.e. prism signs) must follow the European standard EN SS-EN 12899-1:2007 or their national counterparts where applicable.			
Level of Service requirements				
None				

7.2.2.2 Compliance checklist “should”

#	Requirement	Fulfilled?		If no – explanation of deviation
		Yes	No	
Functional requirements				
FR1	Functional decomposition and the provision of standardised interfaces **should** be carried out to ensure interoperability in cases where the service is carried out by more than one organisation (and is in any case recommended to be prepared for an easy functional decomposition, as could be the case in the future). Control and algorithms may be done through local (roadside) or central systems.			
FR2	Traffic Management Centre Operators **should** be trained in supervising the system, be able to control the system manually and override automatic operation. Exception: Local VSL systems sometimes can operate independently and need no supervision regarding current signposted speed limits.			

FR3	The central control system **should** have the ability to supervise and control each individual system. Exception: Local VSL systems sometimes can operate independently and need no supervision regarding current signposted speed limits.			
FR5	To avoid unanticipated deceleration, gradual speed reductions **should** be shown as 20-40 km/h increments, dependent on operating environments, context, speed and road topology (note: 20 km/h reduction between two gantries is common practice on motorways).			
FR6	VSL systems **should** have a log that stores data about signposted speed limits, error messages, etc.			
FR7	Signs **should** report to the control system if message activation was successful or not and possible error messages.			
FR8	Automatic and semi-automatic systems **should** contain models and algorithms that calculate the speed limit and transmit it to the signs. These models and algorithms can be implemented in a central control system or at the roadside.			
FR10	Detector data updating frequency **should** be adapted to the required response times. For instance, a normal updating frequency for traffic data is from real-time to one minute.			
FR11	The systems **should** have predefined handling of situations like power failure, disruptions in communications and other functional problems to avoid functional inconsistencies in the service. System parameters and error states **should** be disseminated in real-time to on-duty staff.			
FR12	If VSL systems interact with other services like hard shoulder running, dynamic lane management or HGV overtaking ban (or adjacent VSL systems), interfaces **should** be implemented either at roadsides or in central control systems. In practice, this can often be internal interfaces in the same system.			
Organisational requirements				
none				

Interface requirements				
IFR3	When relevant, the Variable Speed Limit service **should** collect at interface 3 (see Figure 51) C-ITS coded information such as travel speed, direction, current location of a vehicle on Probe Vehicle Data (microscopic traffic situation) relevant to this ITS Core service.			
Common look & feel requirements				
CL&FR1	Speed limits (maximum) **should** be displayed in one of the following ways: — Discontinuous signs (character matrix): White, off-white or yellow figures on a black background enclosed by a red ring. Discontinuous VMS can also be used without colour inversion if national regulations allow or require this. — Continuous signs (full matrix): Sign surface similar to fixed mandatory speed signs according to national regulations.			
CL&FR2	Advisory speed (recommended) signs **should** be displayed in one of the following ways: — Discontinuous signs (character matrix): White, off-white or yellow figures on a black background. The sign can have a white rectangular border, but no red or white ring. Discontinuous VMS can also be used without colour inversion if national regulations allow or require this. — Continuous signs (full matrix): Sign surface similar to fixed advisory speed signs according to national regulations.			
CL&FR3	Compulsory minimum speed **should** be displayed as a continuous sign (full matrix): Sign surface similar to static minimum speed signs according to national regulations.			
CL&FR4	To avoid driver confusion about which speed limit is valid, static and variable speed limit signs **should** never be mixed along a particular roadway segment. Variable and static speed limit signs must not be located on the same cross-section.			
CL&FR5	It **should** be obvious to the drivers when a section with VSL ends and what the valid speed limit is after that. Normally this is done using fixed speed limit signs.			

CL&FR7	Signs **should** be located either above the carriageway or on the verge of the road. If signs are located on the verge, they **should** be signs on the near side of the road with possible supplementary signs to the offside. If there is more than one lane in the direction of travel, it is recommended to have signs on both sides.			
CL&FR9	Speed limits **should** be repeated at least after every entry slip road, and the distance **should** never exceed 10 km on long stretches or according to national guidelines and operating context.			
Required standards and specifications				
IPS3	When relevant, the Probe Vehicle Data (microscopic traffic situation) information (see IFR3) **should** be collected, which is profiled based on ETSI EN 302 637-2 using the CAR2CAR Communication Consortium Basic System Profile.			
Level of Service requirements				
LoSR1	In the case that pre-deployment surveys / evaluations provide the necessary evidence to proceed with the deployment of the ITS-service "Variable Speed Limits", the minimum and optimum LoS **should** respect the following Level of Service to Operating Environment mapping table. (Table 33)			

7.2.2.3 Compliance checklist "may"

#	Requirement	Fulfilled?		If yes – remarks
		Yes	No	
Functional requirements				
none				
Organisational requirements				
none				
ICT Infrastructure requirements				
none				
Common Look & Feel requirements				
CL&FR6	For certain roadway segments speed limit signs **may** be active only when a reduced speed limit is set. In other cases, they **may** be blank. In some circumstances this makes it easier for the drivers to notice conditions that require a lower speed.			

CL&FR8	If signs are mounted above the carriageway, each lane **may** have one speed limit sign located above (indicating speed limit of that lane only) or a single speed limit sign integrated in a larger VMS, applicable to all lanes.			
Level of service requirements				
none				

7.2.3 TMS-03 Ramp Metering

7.2.3.1 Compliance Checklist "must"

#	Requirement	Fulfilled?		If no – quote of insurmountable reasons
		Yes	No	
Functional requirements				
FR3	Traffic Management Centre Operators (or other dedicated resources) **must** be trained to supervise and manage the systems.			
FR5	Sensors **must** be adapted to the service and give input to the control system. Note: Systems may include both manual and automatic functions as well as several types of sensors. This requires well defined hierarchical rules and priorities.			
FR7	The traffic signals **must** display the stop/go light, that the control system has requested.			
Organisational requirements				
none				
Interface requirements				
IFR1	If the Ramp Metering service provides ramp metering information at interface 1 (see Figure 61), it **must** provide coded information including the following elements: — Location of the ramp metering, either as a linear section or as a group of points (i.e. the effected ramps)			
IFR2	If interface 2 is implemented, the Ramp Metering Service **must** provide at interface 2 (see Figure 61) Ramp Metering information coded in C-ITS messages including the following elements: — Signal phase — Location of the ramp metering			
Common look & feel requirements				
none				

Information provision standards				
IPS1	If the Ramp Metering service provides ramp metering information at interface 1 (see IFR1), it **must** be profiled based on EN 16157-3:2019 using the DATEX II Recommended Service Profile for Ramp Metering			
IPS2	If interface 2 is implemented, Ramp metering information (see IFR2) **must** be profiled in an SPATEM/MAPEM (Signal Phase And Timing Extended Message/MAP Extended Message) based on ETSI TS 103 301 using the C-ROADS C-ITS Message Profiles for the Traffic Light Manoeuvre service.			
Level of Service requirements				
None				

7.2.3.2 Compliance checklist "should"

#	Requirement	Fulfilled?		If no – explanation of deviation
		Yes	No	
Functional requirements				
FR1	Automatic and semi-automatic systems **should** contain models and algorithms that calculate the traffic performance characteristics and transmit it to the ramp metering controller for activation as determined. These models and algorithms can be implemented in a central control system or at the roadside.			
FR2	The systems **should** have predefined handling of situations like power failure, disruptions in communications and other functional problems to avoid functional inconsistencies in the service. System parameters and error states **should** be disseminated in real-time to on duty staff.			
FR4	When ramp metering interacts with other services such as hard shoulder running, or adjacent ramp metering systems, interfaces **should** be implemented either at roadsides or in central control systems.			
FR6	Detector data updating frequency **should** be set correctly in order for the Ramp Metering System to receive enough quality data for the system to operate effectively and in the right circumstances.			

FR8	Ramp metering using fixed release time **should** allow one vehicle per lane to pass during each release phase (green phase).			
FR9	When the signals are connected to are central control system, signals **should** report actively if activation was successful or not and send error messages if errors occur. Functionality (health) of the system **should** be monitored continuously.			
FR10	When connected to a central control system, Ramp metering **should** log all data about the performance of the technical systems and the impact on traffic flow and speed.			
Organisational requirements				
OR1	Inter- and Intra-Agency Coordination - agreements and cooperation **should** be established between all authorities / operators when implementing ramp metering from one network to another (e.g. city authority urban roads to motorways or from one regional operator to another).			
OR2	Public Information Campaign – a formal public information campaign **should** be undertaken in areas where ramp metering is new.			
Interface requirements				
IFR3	When relevant, the Ramp Metering Service **should** collect at interface 3 (see Figure 61) C-ITS coded Probe Vehicle Data information such as travel speed, direction, current location of a vehicle (microscopic traffic situation) relevant to this ITS Core service.			
Common look & feel requirements				
CL&FR1	Ramp metering traffic signals **should** be positioned sufficiently far from the merging point to ensure drivers can accelerate enough to reach the speed of the main carriageway and to maximise the storage space on the on-ramp.			

CL&FR2	The display of signs/pictograms on VMS or other end-user devices **should** be in accordance with prevailing national road codes and: — Member States which ratified the Vienna Convention MUST respect the Vienna Convention and the European agreement supplementing the convention (1st May 1971) and SHOULD consider the Consolidated Resolution on Road Signs and Signals (R.E.2). — Member States which did not ratify the Vienna Convention SHOULD follow the Vienna 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.			
CL&FR3	At least one set of traffic signals **should** be installed per lane			
CL&FR4	Ramp metering traffic signals **should** be installed at the metered on-ramps			
CL&FR6	Fixed or variable warning pre-signs **should** be installed on the on-ramp sufficiently upstream of the traffic lights or the on-ramp entrance			
CL&FR7	The traffic signals **should** operate a "Green – Amber – Red" cycle			
CL&FR8	Ramp metering signals **should** be distinguishable from regular junction signals			
CL&FR9	At locations where ramp metering is applied, the number of vehicles released **should** be communicated to the driver using static information panels stating: " 'x' vehicle per green".			
Required standards and specifications				
IPS3	When relevant, the Probe Vehicle Data (microscopic traffic situation) information (see IFR3) **should** be collected, which is profiled based on ETSI EN 302 637-2 using the CAR2CAR Communication Consortium Basic System Profile.			
Level of Service requirements				
LoSR1	Given that pre-deployment surveys / evaluations provide the necessary evidence to proceed with the deployment of the ITS-service "Ramp Metering", the minimum and optimum LoS **should** respect the Level of Service to Operating Environment mapping table. (Table 35)			

7.2.3.3 Compliance checklist "may"

#	Requirement	Fulfilled? Yes	No	If yes – remarks
Functional requirements				
none				
Organisational requirements				
none				
ICT Infrastructure requirements				
none				
Common Look & Feel requirements				
CL&FR5	Traffic signals **may** additionally be installed conform to national regulations			
Level of service requirements				
none				

7.2.4 TMS-04 Hard Shoulder Running

7.2.4.1 Compliance Checklist "must"

#	Requirement	Fulfilled? Yes	No	If no – quote of insurmountable reasons
Functional requirements				
FR1	Incident detection and verification **must** be possible for the whole Hard Shoulder Running section. Incident detection does not need to be automated.			
FR3	Safety protocols and instructions **must** be documented and used to ensure the opening, running and closing of the Hard Shoulder Running is done safely.			
FR4	In case of failure of the Hard Shoulder Running signalization the system **must** be entered immediately into a safe state.			
Organisational requirements				
none				

Interface requirements				
IFR1	If the Hard Shoulder Running service provides hard shoulder information at interface 1 (see Figure 64), it **must** provide coded Hard Shoulder Running information including the following elements: — Location (section) of the Hard Shoulder Running section — Status of the hard shoulder (open/close) — Speed limit — Type of vehicles			
IFR2	If interface 2 is implemented, the Hard Shoulder Running service **must** provide at interface 2 (see Figure 64) Hard Shoulder Running information coded in C-ITS messages including the following elements: — Allocation and spatial dimension of the Hard Shoulder Running section — Road signs for Hard Shoulder Running (HSR is open, HSR is clearing) — Road signs for variable speed limit — Type of vehicles			
Common look & feel requirements				
none				
Information provision standards				
IPS1	If a Hard Shoulder Running service is implemented at interface 1, the information (see IFR1) **must** be profiled based on EN 16157-3:2019 using the DATEX II Recommended Service Profile for Hard Shoulder Running.			
Level of Service requirements				
None				

7.2.4.2 Compliance checklist "should"

#	Requirement	Fulfilled? Yes	No	If no – explanation of deviation
Functional requirements				
FR2	Detection and verification time, as well as reaction time, **should** be as short as possible.			
FR6	Before starting the Hard Shoulder Running opening/closing procedure, continuous traffic monitoring **should** be carried out along the entire section of Hard Shoulder Running including the hard shoulder as well as upstream and downstream road sections (network effects).			

Organisational requirements				
none				
Interface requirements				
IFR3	Incoming DENM from end users/vehicles are checked for safety-relevant facts that lead to the HSR being switched off or prevented from being switched on (e.g. stationary vehicles on the hard shoulder, obstacles on the hard shoulder lane). When relevant, the Hard Shoulder service **should** collect at interface 3 (see Figure 65) C-ITS coded Probe Vehicle Data information such as travel speed, direction, current location of a vehicle (microscopic traffic situation) relevant to this ITS Core service.			
Common look & feel requirements				
CL&FR1	The display of signs/pictograms on VMS or other end-user devices **should** be in accordance with prevailing national road codes and: Member States which ratified the Vienna Convention MUST respect the Vienna Convention and the European agreement supplementing the convention (1st May 1971) and SHOULD consider the Consolidated Resolution on Road Signs and Signals (R.E.2). Member States which did not ratify the Vienna Convention SHOULD follow the Vienna Convention and also consider the R.E.2.			
CL&FR2	Safe havens/ERAs **should** be provided in order to create safe zones for broken down vehicles.			
CL&FR3	Safe havens/ERAs **should** ensure a safe use (length and width).			
CL&FR4	The maximum distance between safe havens/ ERAs **should** be 1000m.			
CL&FR5	Road markings at junctions and cross sections **should** be in line with general standards used for road sections without Hard Shoulder Running.			
CL&FR6	Indications for an open or closed hard shoulder **should** be located at a distance which ensures the road user has good visibility of the successive signals/signs along the relevant stretch of road.			
CL&FR7	Hard shoulder is closed **should** be displayed according to either Figure 65 or Figure 66			
CL&FR8	Hard shoulder is open **should** be displayed according to either Figure 67 or Figure 68			

CL&FR9	Hard shoulder is clearing **should** be displayed according to either Figure 69 or Figure 70			
CL&-FR10	End of hard shoulder section **should** be displayed according to either Figure 71 or Figure 66			
Required standards and specifications				
IPS2	When relevant, Hard Shoulder Running information (see IFR2) **should** be profiled in an IVIM (infrastructure to vehicle information message) based on ISO 19321 using the C-ROADS C-ITS Message Profiles for the In-Vehicle Signage service.			
IPS3	When relevant, the Probe Vehicle Data (microscopic traffic situation) information (see IFR3) **should** be collected, which is profiled based on ETSI EN 302 637-2 using the CAR2CAR Communication Consortium Basic System Profile.			
Level of Service requirements				
LoSR1	In the case that pre-deployment surveys / evaluations provide the necessary evidence to proceed with the deployment of the ITS-service "Hard Shoulder Running", the minimum and optimum LoS **should** respect the following Level of Service to Operating Environment mapping table. (Table 37)			

7.2.4.3 Compliance checklist "may"

#	Requirement	Fulfilled? Yes	No	If yes – remarks
Functional requirements				
none				
Organisational requirements				
none				
ICT Infrastructure requirements				
none				
Common Look & Feel requirements				
none				
Level of service requirements				
none				

7.2.5 TMS-05 HGV Overtaking Ban

7.2.5.1 Compliance Checklist "must"

#	Requirement	Fulfilled?		If no – quote of insurmountable reasons
		Yes	No	
Functional requirements				
none				
Organisational requirements				
OR1	The organisational and operational structure of the service, as well as the role of each organisation/body and its tasks, **must** be compliant with the National Access Points across Europe, within the scope of the implementation of the delegated acts adopted under Directive 2010/40/EU.			
OR2	In the case where road operators have to exchange data requiring interoperability between two or more different organisation[50], they **must** enable their system to use DATEX II".			
OR3	Along the same line as OR2 (In the case that road operators have to exchange data requiring interoperability between two or more different organisations, they **must** enable their system to use DATEX II). Services operators **must** be able to integrate the DATEX II publications provided by the road operators when they publish the ban information measure.			
Interface requirements				
IFR1	If the HGV Overtaking Ban service provides HGV Overtaking Ban information at interface 1 (see Figure 72), it **must** provide coded information including the following elements: — Location (section) of the HGV overtaking ban — If applicable the affected lanes (esp. on carriageways with more than two lanes) — If applicable a specification of the affected vehicles (e.g. characterised by their weight) — Start time, and, if applicable, the end time of the HGV overtaking ban.			

50 In the TTIS context, 'organisations' mean Traffic and Traveller Data providers and Service providers.

IFR2	If interface 2 is implemented, the HGV Overtaking Ban service **must** provide at interface 2 (see Figure 72) HGV Overtaking Ban information coded in C-ITS messages including the following elements: — the respective road sign for the overtaking ban			
Common look & feel requirements				
CL&FR3	In the case that the HGV ban is implemented for specific categories of lorries (> 12 Tonnes for example), the C 13ba panel **must** be completed with an additional panel type H,1 which will specify the tonnage of HGV concerned (without tonnage precision the ban applies for HGV > 3.5t)			
CL&FR4	The end of the dynamic ban section **must** be signalled, when this end is provided with VMS. The panel to be used is the XC17 d panel			
Information provision standards				
IPS1	If a HGV Overtaking Ban service is implemented at interface 1, the information (see IFR1) **must** be profiled based on EN 161573:2019 using the DATEX II Recommended Service Profile for **HGV overtaking ban**			
IPS2	If interface 2 is implemented, HGV Overtaking Ban information (see IFR2) **must** be profiled using an IVIM based on ISO 19321 using the C-ROADS C-ITS Message Profiles for the In-Vehicle Signage service, specifically the Traffic Sign Use Case.			
Level of Service requirements				
None				

7.2.5.2 Compliance checklist "should"

#	Requirement	Fulfilled? Yes	No	If no – explanation of deviation
Functional requirements				
FR2	for the dynamic service it is recommended that the data collection system **should** be able to detect real-time traffic data (e.g. vehicle flow, speed and HGV% per lane).			
Organisational requirements				
none				

Interface requirements				
IFR3	When relevant, the HGV Overtaking Ban service **should** collect at interface 3 (see Figure 72) C-ITS coded Probe Vehicle Data information (microscopic traffic situation) relevant to this ITS Core service.			
Common look & feel requirements				
CL&FR2	The dynamic HGV overtaking ban **should** require the use of VMS (or prism) display. The icon is the C, 13ba panel			
CL&FR5	In order to remind drivers of the dynamic ban when driving, VMS **should** be installed no more than 10km apart.			
CL&FR6	For the dynamic overtaking ban, a VMS **should** be installed on the motorway section just after the entrance.			
CL&FR9	The display of signs/pictograms on VMS or other end-user devices **should** be in accordance with prevailing national road codes and: — Member States which ratified the Vienna Convention MUST respect the Vienna Convention and the European agreement supplementing the convention (1st May 1971) and SHOULD consider the Consolidated Resolution on Road Signs and Signals (R.E.2). — Member States which did not ratify the Vienna Convention SHOULD follow the Vienna Convention and also consider the R.E.2.			
Required standards and specifications				
IPS3	When relevant, the Probe Vehicle Data (microscopic traffic situation) information (see IFR3) **should** be collected, which is profiled based on ETSI EN 302 637-2 using the CAR2CAR Communication Consortium Basic System Profile.			
Level of Service requirements				
LoSR1	The Level of Service to Operating Environment mapping table does not imply any obligation to deploy ITS services. However, if services are deployed, they **should** comply with the table. Given that pre-deployment surveys / evaluations provide the necessary evidence to proceed with the deployment, the minimum and optimum LoS **should** respect the Level of Service to Operating Environment mapping table. (Table 41)			

7.2.5.3 Compliance checklist "may"

#	Requirement	Fulfilled? Yes	Fulfilled? No	If yes – remarks
Functional requirements				
FR1	It is recommended to prepare HGV Overtaking ban service implementation with an easy functional decomposition. The proposed seven sub functions **may** be followed when implementing the service.			
Organisational requirements				
none				
ICT Infrastructure requirements				
TR1	The data collection system **may** be able to detect in real-time the following parameters: vehicle flow, speed and HGV%.			
TR2	Relevant data input **may** be provided by local detection points on all lanes and/ or by floating car data.			
TR3	After the ban area a station to collect journey time information for the evaluation purposes **may** be implemented.			
Common Look & Feel requirements				
CL&FR1	A wide area deployment of this service **may** limit the length of the ban to 20 km on a section.			
CL&FR7	Additional dynamic information using VMS **may** also be installed on the motorway access.			
CL&FR8	Additional dynamic information using VMS **may** also be installed at the exit of the rest and service areas.			
Level of service requirements				
none				

7.2.6 TMS-06 Incident Warning and Management

7.2.6.1 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.).			
FR2	Detection/discovery of events or conditions and collection of data: In accordance with Delegated Regulation (EU) No 886/2013 on SRTI, public and private road operators and/or service providers **must** set up or use the means to detect events or identify conditions on the SRTI designated sections of the road network, and **must** distribute the available road safety-related traffic data through a National Access Point. The deployment of these means **must** comply with the conditions and requirements set out in national law.			
FR4	Clearance of the road: measures **must** be taken to enable IM responders to gain safe access to the incident. To enable restoration to normality the incident scene **must** 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.			
Organisational requirements				
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.			

Interface requirements				
IFR1	If the Incident Warning and Management service provides incident warning management information at interface 1 (see Figure 84), it **must** provide coded information including the following elements: — Location of the incident — Type of incident — Actions taken by authorities and road operators to deal with the incident — Start time, and, if applicable, the end time of the incident			
IFR2	If interface 2 is implemented, the Incident Warning and Management service **must** provide at interface 2 (see Figure 84) Incident Warning and Management information coded in C-ITS messages including the following elements: — the respective road sign and text on the road sign (gantry) — the location of the accident — when relevant, the length and affected lanes of a traffic jam — the location of the affected vehicles — when relevant, the location of persons on the road — when relevant, the location of obstacles (such as car parts) on the road — when relevant, the presence of an emergency vehicle — when relevant, the presence and location of a blockage of a road (e.g. because of a heavy goods vehicle incident)			
Common look & feel requirements				
CL&FR7	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 or distance marker post information, ERT - Emergency Road Telephone			
Information provision standards				
IPS1	If the Incident Warning and Management service provides dynamic road status data and/or traffic data (to road users) at interface 1 (see IPR1), the provision of **must** be compliant to Delegated Regulation (EU) No 2015/962.			

IPS2	Information content: In accordance with Article 4 of the Delegated Regulation (EU) No 886/2013, the information provided on the road safety-related events or conditions on SRTI designated sections of the road network **must** include the items listed below. The information shall be withdrawn if the event or condition cease to subsist or shall be modified if there is a change in the event or condition. — Location of the event or the condition — The category of event or condition as referred to in Article 3 of the SRTI Delegated Regulation and, where appropriate, a short description of it — Driving behaviour advice, where appropriate.			
IPS3	Availability, exchange and reuse of data: Public and/or private road operators and/or service providers **must** share and exchange the data they collect on SRTI designated sections of the road network pursuant to Article 6 of the Delegated Regulation (EU) No 886/2013, or Functional Requirement 2, in compliance with Article 7 of the Delegated Regulation (EU) No 886/2013.			
IPS4	Dissemination of Information: In accordance with Article 8 of the Delegated Regulation (EU) No 886/2013, public road operators, service providers and broadcasters dedicated to traffic information **must** provide road safety-related minimum universal traffic information of SRTI designated sections of the road network to end users prior to the provision of any other non-safety-related traffic information. The information service **must** be compliant with Delegated Regulation (EU) No 886/2013 Article 8.			
Level of Service requirements				
None				

7.2.6.2 Compliance checklist "should"

#	Requirement	Fulfilled? Yes	No	If no – explanation of deviation
Functional requirements				
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.			
FR7	Information to road users: road users **should** be warned about the impact of the incident e.g. dynamic road status data (like temporary traffic management measures and road or lane closures) and traffic data (like location and length of traffic queues and travel times).			
FR8	Site investigation: investigation **should** 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 **should** be analysed and used to optimize the IM process.			
Organisational requirements				
OR1	For the effective functioning of the IM process, all IM partners **should** cooperate not only during incidents but also in planning and evaluation. This ensures the continuity and the enhanced quality of the IM process.			
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.			

Interface requirements				
IFR3	When relevant, the Hard Shoulder Service **should** collect at interface 3 (see Figure 84) C-ITS coded Probe Vehicle Data information such as travel speed, direction, current location of a vehicle (microscopic traffic situation) relevant to this ITS Core service.			
Common look & feel requirements				
CL&FR1	In dangerous situations at least a danger warning **should** be used as a minimum.			
CL&FR2	If VMSs are available, warning signs **should** be used if possible.			
CL&FR3	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 International Law (Vienna Convention) and national laws.			
CL&FR6	The display of signs/pictograms on VMS or other end-user devices **should** be in accordance with prevailing national road codes and: — Member States which ratified the Vienna Convention MUST respect the Vienna Convention and the European agreement supplementing the convention (1st May 1971) and SHOULD consider the Consolidated Resolution on Road Signs and Signals (R.E.2). — Member States which did not ratify the Vienna Convention SHOULD follow the Vienna Convention and also consider the R.E.2. — It is up to the deploying road operator to ensure that physical signs are well and widely understood by the road users.			

Required standards and specifications				
IPS5	If interface 2 is implemented, Incident Warning and Management information regarding the in-vehicle signage of road signs (see IFR2) **should** be profiled in an IVIM (Infrastructure to Vehicle Information Message) based on ISO 19321 using the C-ROADS C-ITS Message Profiles for the In-Vehicle Signage service. Additionally, all other Incident Warning and Management information (see IFR2) should be profiled in a DENM (Decentralized Environmental Notification Message) based on ETSI EN 302 637-2 using the C-ROADS C-ITS Message Profiles for the DEN Basic service.			
IPS6	When relevant, the Probe Vehicle Data (microscopic traffic situation) information (see IFR3) **should** be profiled based on ETSI EN 302 637-2 using the CAR 2 CAR Communication Consortium Basic System Profile.			
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. (Table 43)			

7.2.6.3 Compliance checklist "may"

#	Requirement	Fulfilled?		If yes – remarks
		Yes	No	
Functional requirements				
none				
Organisational requirements				
none				
ICT Infrastructure requirements:				
none				
Common Look & Feel requirements				
CL&FR4	The type of incident **may** be clearly defined on the VMS (if the VMS is fitted with lines and alphanumeric characters).			

CL&FR5	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 International Law (Vienna Convention) and national laws.			
Level of service requirements				
none				

7.2.7 TMS-07 Traffic Management for Corridors and Networks

7.2.7.1 Compliance Checklist "must"

#	Requirement	Fulfilled?		If no – quote of insurmountable reasons
		Yes	No	
Functional requirements				
FR1	Decomposition of the TMP elaboration phase into sub-phases (process steps) with the provision of intermediate deliverables **must** be carried out in those cases where the service is carried out by two or more (not closely related) organisations (and decomposition is recommended in any case to be prepared to involve yet further parties as may be the case in the future).			
FR2	A TMP feasibility study or cost/benefit analysis **must** be processed and a TMP feasibility document as intermediate deliverable 1 **must** be delivered as input for the next sub-phase (TMP framework development).			
FR3	Based on the input of sub-phase TMP feasibility document (intermediate deliverable 1) a sub-phase TMP framework development **must** be processed and a TMP framework document as intermediate deliverable 2 **must** be delivered as input for the next sub-phase (TMP development).			
FR4	Based on the input of sub-phase TMP framework development (intermediate deliverable 2) a sub-phase TMP scenario development **must** be processed and a "TMP scenarios publication" as intermediate deliverable 3 **must** be delivered as input for the next phase (TMP operation).			

FR5	Functional decomposition of the TMP operation phase into sub-functions with the provision of interfaces **must** be carried out to ensure interoperability in those cases where the service is carried out by two or more (not closely related) organisations (and functional decomposition is recommended in any case to be prepared to involve yet further parties as may be the case in the future).			
FR6	For the purpose of information exchange between partners and bodies involved in TMP-service a “TMP operation publication” **must** be generated and published showing the scenario which was selected corresponding to an initial situation and the current status of operation.			
FR7	Important and frequently applied TMPs **must** be assessed and preferably periodically adjusted and a TMP evaluation document as intermediate deliverable 6 **must** be delivered as input for a possible necessary improvement of the TMP operation. Hence an evaluation model and an evaluation process **must** be defined.			
Organisational requirements				
OR1	All different stakeholder roles needed to be involved in the three phases of the service **must** be considered and defined (role concept).			
OR6	Stakeholders involved in service operation **must** agree on one of the following operational organisational structures: — centralized structure — decentralized structure — mixture of centralised and decentralised structure			
Interface requirements				
IFR1a	A Traffic Management for Corridors and Networks service **must** provide coded “TMP scenario information” at interface 1 (see Figure 96), including the following elements: — The details of proposed traffic management plans, including the scenario for which they are applicable, and the definition of measures and actions that shall be taken as part of the traffic management plan			

IFR1b	A Traffic Management for Corridors and Networks service **must** provide coded “TMP in operation information” at interface 1 (see Figure 96), including the following elements: — Status information and status change information relating to elements of a traffic management plan. The information may relate to a previously defined traffic management plan or a traffic management plan that has not previously been defined.			
IFR2	If interface 2 is implemented, the Traffic Management for Corridors and Networks service **must** provide at interface 2 (see Figure 96) Traffic Management information coded in C-ITS messages including the following elements: — the information and setting of the sign			
Common look & feel requirements				
none				
Required standards and specifications				
IPS1a	If the Traffic Management service for Corridors and Networks provides TMP scenarios at interface 1 (see IFR1a), they **must** be profiled based on CEN/TS 16157-8:2020 (DATEX II).			
IPS2	If interface 2 is implemented Traffic Management for Corridors and Networks information (see IFR2) **must** be profiled using an IVIM based on ISO 19321 using the C-ROADS C-ITS Message Profiles for the In-Vehicle Signage service.			
Level of Service requirements				
None				

7.2.7.2 Compliance checklist “should”

#	Requirement	Fulfilled?		If no – explanation of deviation
		Yes	No	
Functional requirements				
FR8	The TMP evaluation process **should** compile various sources of information like: — Statistical traffic data — Experiences of road authorities and operators — Survey of incidents with Scenarios (and measures) activated — Interviews and questionnaires with operators and road users — ...			

Organisational requirements				
OR2	For the TMP Feasibility study process the following (or comparable) process steps **should** be executed: — Definition of common policy goals and common interests, consideration of legal bases, regulatory framework — Identification and analysis of the influence area (geographic area) which is often variable and dependent on the incident type and duration (capacity reduction) and the affected resource (network capacity) — Identification and analysis of bottlenecks, in accordance with the OE-classification (sections of an acceptable route with a traffic capacity substantially below that characterizing other sections of the same route). — Inventory of existing (road rail harbour and other) infrastructure (capacity, technical control and equipment packages, communication, topology, traffic ability for different vehicles, planned extensions) — Statistical surveys of traffic volumes and speeds (if possible, including aspects of traveller behaviour) — Survey of traffic characteristics (share of vehicle types, share of local, regional and long-distance traffic, destination of traffic etc.) — Approach for detecting incidents: ▪ Preliminary detection of problems / incidents (possible proceedings: interviews with experts, analysis of traffic messages, incident database, calculation of the estimated occupancy, control tours, analysis of system data) ▪ Manual / Real-time detection ▪ Inventory of existing and planned monitoring systems, control systems and information systems ▪ Definition of current, planned and necessary additional technical infrastructure			

OR3	For the TMP development process the following (or comparable) steps **should** be executed: — TMP development ▪ Categorisation of incidents, definition of incident thresholds for activation of a TMP ▪ Definition of other thresholds / conditions for TMP activation at the local and cross-organisational levels ▪ Development of methods for detection / control ▪ Location codes and geo-referencing frameworks ▪ Development of measures and actions ▪ Strategy prioritization in case of overlapping strategies / interests ▪ Strategy transitional phases, if needed ▪ Thresholds / conditions for activation and deactivation ▪ Development of computerised decision support tools such as traffic situation and impact modelling and strategy selection advisor, when necessary ▪ Organisational / technical aspects of evaluation / quality management ▪ Update and refinement of developed TMPs ▪ Formal approval of strategies and measures ▪ Set up of organisational structure for full-scale elaboration and monitoring ▪ Full-scale elaboration of TMPs — TMP validation by stakeholders, piloting refinement ▪ Formal approval of strategies and measures ▪ Set up of organisational structure for full-scale elaboration and monitoring ▪ Field testing of TMPs (if possible) ▪ Update and refinement of developed TMPs ▪ Full-scale elaboration of applicable TMPs			
OR4	For the successful implementation of a “Traffic Management for Corridors and Networks service” all necessary organisational aspects **should** be documented and agreed by all involved parties/ partners to fix the co-operation.			
OR5	In the case of involving private partners for the delivery of privately generated data for a Traffic Management for Corridors and Networks service, a service level agreement **should** be developed and closed wherever a TMP relies on receiving privately generated data.			

Interface requirements				
IFR3	When relevant, the Traffic Management for Corridors and Networks service **should** collect at interface 3 (see Figure 96) C-ITS coded Probe Vehicle Data information such as travel speed, direction, current location of a vehicle (microscopic traffic situation) relevant to this ITS Core service.			
Common look & feel requirements				
CL&FR1	In order to facilitate the comprehension of TMP documents between various bodies they **should** respect the common structure of the TMP framework document (intermediate deliverable 2), called TMP Fact Sheet (see Table 44 and Table 45)			
Required standards and specifications				
IPS3	When relevant, the Probe Vehicle Data (microscopic traffic situation) information (see IFR3) **should** be collected, which is profiled based on ETSI EN 302 637-2 using the CAR2CAR Communication Consortium Basic System Profile.			
Level of Service requirements				
LoSR1	In the case that pre-deployment surveys / evaluations provide the necessary evidence to proceed with the deployment of the ITS-service "Traffic Management for Corridors and Networks", the minimum and optimum LoS **should** respect the following Level of Service to Operating Environment mapping table. (Table 47)			

7.2.7.3 Compliance checklist "may"

#	Requirement	Fulfilled?		If yes – remarks
		Yes	No	
Functional requirements				
none				
Organisational requirements				
none				
ICT Infrastructure requirements:				
none				
Common Look & Feel requirements				
none				
Level of service requirements				
none				

7.3 F&LS - Freight & Logistic Services

7.3.1 F&LS-01 Intelligent and Secure Truck parking

7.3.1.1 Compliance Checklist "must"

#	Requirement	Fulfilled?		If no – quote of insurmountable reasons
		Yes	No	
Functional requirements				
FR1	The data provided for static information must be based on a consistent and geographic reference mode, which must be part of data description. Note: In compliance with Delegated Regulation (EU) 885/2013, the geographic references must include latitude/longitude information of the entry point in the parking area, primary road identifier/direction (plus a second primary road identifier/direction, if the parking area is accessible from two different roads) plus - if needed - the indication of the exit to be taken from the primary road plus distance to the parking area in km or miles.			
FR3	Source, scope and quality of data provided **must** be defined and **must** be part of data interface description.			
FR4	The geographical basis for dynamic information **must** be the same or compatible as the one for static information.			
FR5	The data provided **must** be based on a consistent and geographic reference model and a time validity model. For defined priority zones dynamic parking data must be included in the NAP (when available).			
FR10	Traffic signs being used for information dissemination **must** be compliant with the requirements of the Vienna Convention on Road Traffic Signs, where a Member has signed it. This means that the colours red, yellow and green cannot be used to show "the degree of occupation" of the truck parking area. Signs with language dependent written messages such as "free" should not be used.			

51 The current text of 885/2013 is phrased "number of free parking spaces". This seems to be either an editorial error or a very ambiguous phrasing, since this is the section for static data. What is meant is the total number of spaces, independent of the current occupancy.
52 More information: www.gdpr.eu

FR12	According to Delegated Regulation 885/2013 article 5 public or private parking operators and service providers **must** share and exchange data in DATEX II (CEN/TS 16157) format or any DATEX II compatible international machine-readable format. Data shall be accessible for exchange and reuse by any public or private information service provider and/or parking operator on a non-discriminatory basis, and in accordance with access rights and procedures defined in Directive 2003/98/EC.			
Organisational requirements				
OR1	The organisational and operational structure of the service as well as the role of each organisation/body and its exact tasks in the chain **must** be defined. These parties and their role in the organisational structure of the ITP-service demand special attention and finally agreements/ contracts.			
OR2	Contracts/agreements **must** be established, which set up the rules of cooperation.			
OR3	Collaboration processes/workflows and interfaces **must** be described.			
OR5	A Quality Management and Assessment of compliance with the requirements systems **must** be set up according to Articles 7 and 8 of Delegated Regulation (EU) 885/2013. Details of these procedures **must** be clarified with the designated national competent body in charge of assessment of compliance with Delegated Regulation (EU) 885/2013.			

Interface requirements				
IFR1a	The Intelligent and Secure Truck Parking service **must** provide at interface 1 (see Figure 101) basic static information according to Delegated Regulation (EU) 885/2013 Article 4 paragraph 1 and 2: — Identification information of parking area (name and address) (200 characters) — Location information of the entry point in the parking area (20+20 characters) — One or two primary road identifier/direction pairs, depending on whether the parking area is accessible from one or two different roads (20+20 characters each). — Indication of the exit to be taken (100 characters) and distance from primary road in km or miles (3-digit integer) — Total number of parking places for trucks (3-digit integer)[51] — Price and currency of parking places (300 characters) — Description of security, safety and service equipment of the parking including national classification if one is applied (500 characters) — Number of parking places for refrigerated goods vehicles (numerical 4 digits) — Information on specific equipment or services for specific goods vehicles and other (300 characters) — Contact information of the parking operator ▪ Name and surname (100 characters ▪ Telephone number (20 characters) ▪ E-mail address (50 characters) ▪ Consent of the operator to make his contact information public (Yes/No) **Note:** For the collection, processing and storage of information the General Data Protection Regulation (GDPR) applies[52].			
IFR1c	The Intelligent and Secure Truck Parking service **must** provide at interface 1 (see Figure 101) DATEX II or any DATEX II compatible international machine-readable format coded dynamic information including the dynamic data on availability of parking places including whether a parking is: — full, — closed or — number of free places which are available.			

IFR2	If interface 2 is implemented, the Intelligent and Secure Truck Parking service **must** provide at interface 2 (see Figure 101) truck parking information coded in C-ITS messages including the following elements: — full, — closed or — number of free places which are available.			
Common look & feel requirements				
CL&FR1	The website **must** provide a description of the services in the local language for the 'Home' section.			
Required standards and specifications				
IPS1	If a Service for Intelligent and Secure Truck parking is implemented at interface 1 the information (see IFR1) **must** be profiled based using the "DATEX II Profile for Truck Parking" defined in CEN/TS 16157-6:2016 or any international machine-readable format fully compatible and interoperable with DATEX II.			
Level of Service requirements				
None				

7.3.1.2 Compliance checklist "should"

#	Requirement	Fulfilled?		If no – explanation of deviation
		Yes	No	
Functional requirements				
FR7	Data **should** be described using metadata[53] to make it easier to search data, to make the data machine-readable and to improve common understanding of the data.			
FR8	Data **should** be described in English language as a minimum and possibly also other languages.			
FR9	The geographical area of information dissemination **should** take into account the characteristics of the information transmission channel used.			

53 There are different 'standards' for metadata (coordinated metadata catalogue, DCAT-AP). A guideline on metadata is available here: https://www.its-platform.eu/filedepot_download/1976/6295
54 An example reference for security features is the „Study on Safe and Secure Parking Places for Trucks": https://ec.europa.eu/transport/sites/transport/files/2019-study-on-safe-and-secure-parking-places-for-trucks.pdf

Organisational requirements				
OR4	The information provision **should** be in accordance with any management plans which are in operation of the road authorities or traffic management centres.			
Interface requirements				
IFR1b	The Intelligent and Secure Truck Parking service **should** provide at interface 1 (see Figure 101) advanced static information about the parking area type: — truck only/ "combined" parking facility (including non-goods vehicle) — number of spaces for cars, busses (defined by operator) — service features (facilities, fuel card, security[54])			
IFR3	When relevant, the Intelligent and Secure Truck Parking service **should** collect at interface 3 (see Figure 101) C-ITS coded Probe Vehicle Data information (microscopic traffic situation) relevant to this ITS Core service.			
Common look & feel requirements				
CL&FR2	The display of signs/pictograms on VMS or other end-user devices **should** be in accordance with prevailing national road codes and: — Member States which ratified the Vienna Convention MUST respect the Vienna Convention and the European agreement supplementing the convention (1st May 1971) and SHOULD consider the Consolidated Resolution on Road Signs and Signals (R.E.2). — Member States which did not ratify the Vienna Convention SHOULD follow the Vienna Convention and also consider the R.E.2.			
Level of Service requirements				
None				

7.3.1.3 Compliance checklist "may"

#	Requirement	Fulfilled?		If yes – remarks
		Yes	No	
Functional requirements				
FR2	The geographical basis for static and dynamic information **may** be left to the involved partners to define.			
FR6	Historic dynamic information data **may** also be required for algorithms or forecast.			
FR11	To foster interoperability between all parties involved (content providers/non-technical sources, service operators, service providers) the sub-function **may** provide interfaces conforming to the following information structure: — static information — dynamic information — comment (free text) — information source			
Organisational requirements				
none				
ICT Infrastructure requirements:				
none				
Common Look & Feel requirements				
none				
Level of service requirements				
none				

7.3.2 F&LS-02 Access top Abnormal Goods Transport Regulation

7.3.2.1 Compliance Checklist "must"

#	Requirement	Fulfilled?		If no – quote of insurmountable reasons
		Yes	No	
Functional requirements				
FR1	The website **must** provide information on 'EU rules and regulations for abnormal transports'. The user gets all the necessary information regarding the application procedure in the section 'Application' (see Figure 103: Sitemap draft), which presents the information according to Member States and subdivided into the sections 'Contact' and 'Application form'. If there are national online application services in place, the application data may be transferred directly to the corresponding system. Otherwise, the data may be transferred to an application form ready for printing or sending. At the very least, the necessary application forms should be linked to the service.			
FR3	The website **must** provide information on the question: 'How to apply for a special permit?'			
FR3	The service **must** explain the formal procedure. Application forms can be offered for download. If an online application system exists, the link to this service should be provided. A guide through the application process is recommended. All these services can be provided on the national website and be made available by an external link.			
Organisational requirements				
OR3	One contact person for the participating Member State **must** be available for guaranteeing the websites' accuracy and topicality.			
OR5	Update processes **must** be defined and implemented so that the offered information is always up to date.			
ICT Infrastructure requirements				
None				
Common look & feel requirements				
CL&FR1	The website **must** provide a description of the services in the local language for the 'Home' section.			

CL&FR2	The website **must** provide the section, 'EU rules and regulations' in the local language and in English in order to provide information on procedures in individual EU states.			
CL&FR3	The website **must** provide a table containing relevant dimensions as input for the database in the section, 'Does my transport need a special permit?'			
CL&FR4	The website **must** provide a general description of the national application procedures, including a link to national application forms, relevant contact information for the application procedure and any additional documents a country would like to make available for download purposes. This information must be provided in English and the local language.			
CL&FR5	The website **must** provide a translation of the websites' general text highlights describing the web service for users in the local language.			
Level of Service requirements				
None				

7.3.2.2 Compliance checklist "should"

#	Requirement	Fulfilled?		If no – explanation of deviation
		Yes	No	
Functional requirements				
FR2	The website **should** provide information on the question: 'Does my transport need a special permit?'			
Organisational requirements				
OR1	Resources and organisations **should** be made available for operating appropriate services as mentioned in chapter 5.3.2.3 in an integrated manner.			
OR2	Resources and organisations **should** be made available for the development of a common umbrella for these services.			
OR4	Regular quality improvement loops **should** be established in which user feedback is integrated and the quality of the service can constantly be improved.			
OR6	Resources **should** be made available for dissemination and promotion activities for the service.			

ICT Infrastructure requirements				
none				
Common look & feel requirements				
None				
Level of Service requirements				
None				

7.3.2.3 Compliance checklist "may"

#	Requirement	Fulfilled? Yes	No	If yes – remarks
Functional requirements				
none				
Organisational requirements				
none				
ICT Infrastructure requirements:				
TR1	A DATEX II data model **may** be used to exchange data.			
Common Look & Feel requirements				
none				
Level of service requirements				
none				

7.3.2.4 Special compliance checklist "Level of Service Criteria"

#	Requirement	Fulfilled? Yes	No	If no – quote of insurmountable reasons
Compliance Checklist: Provision				
LoSC1	Compliance check LEVEL A			
	Do you provide information regarding restrictions and regulations for abnormal transports on an Internet platform in your local language?			
LoSC2	Compliance check LEVEL B (additional to level A)			
	Do you provide information regarding restrictions and regulations for abnormal transports on an Internet platform in English?			
LoSC3	Compliance check LEVEL C (additional to level B)			
	Is this information service connected to a European portal?			

Compliance Checklist: Query				
LoSC4	Compliance check LEVEL A			
	Is it possible to make a query on whether the transport is subject to special requirements and needs specific permissions?			
Compliance Checklist: Application				
LoSC5	Compliance check LEVEL A			
	Is the query connected to an online application?			

8

Annex C: Operating Environment Classification

8 Annex C: Operating Environment Classification

8.1 Introduction

The purpose of this annex is to provide guidance on the classification of a road network into operating environments on the basis of three criteria:

- Physical characteristics – Motorways, Other roads
- Network typology or traffic management orientation – Corridor, Network, Link or Critical spot
- Traffic characteristics – Traffic flow and road safety situations (with optional additions)

The basic steps in carrying out the classification are summarised below.

Establish a task force

The first step in the process is to establish a task force (recommended 2-4 people) within the relevant road operator organization to decide on which background information to use, which criteria for flow and safety to use etc. This operating environment classification document gives suggestions on how to accomplish this, including a range of threshold values that are recommended to be applied in order to ensure a harmonized approach.

Road network definition

The next step in the classification process is to decide on the extent of the road network concerned. This could be, for instance, the TEN-T Road Network under the road operator's responsibility, with the addition of other key road network elements, interfaces to urban networks etc. The precise extension of the network is decided by the organisation carrying out the classification. All elements should be matched with a common and gapless map database.

Book resources needed for road network classification

According to earlier experiences, a "typical" national road operator's road network will result in 200-500 links. 2-3 experts are able to carry out the classification within a few (2-4) working days when preparations (the previous steps) have been made.

Classification

Classification is made through a link-by-link (from one exit/major junction to another exit/major junction) analysis supported by a dedicated Exceltool. By defining the value of the three criteria (above), the tool will provide the resulting Operating Environment in the Excel table.

8.2 Understanding the classification criteria and attributes

This chapter describes the attributes used for classification of Operating Environments.

8.2.1 Physical characteristics

One of the key elements in an Operating Environment is the physical layout of the road section itself. The road user is naturally well aware of the road, which he/she is using, and will base his/her expectancies on the ITS as well as other services on the road type. There are two basic types of roads with regard to the Operating Environments:

- motorways: two or more lanes in both driving directions with separation of the carriageways of each direction, no at-grade intersections with other roads (intersections are handled by over- and underpasses with ramps)
- all other roads than motorways; usually one or two driving lanes in each direction, no physical separation or a fence and/or barrier or without a barrier between driving directions, typically ground level intersections with other roads; in case of four-lane road, a dual carriageway road with separation of the two carriageways of two lanes each allowing also at-grade intersections.

Only lanes for motor vehicles (including dedicated bus lanes) are included in the counting of lanes. If there are more than two lanes in at least one of the driving directions, but it is not a case of being a motorway, the road should be classified among other roads than motorways. Hard shoulders should not be counted as lanes, even if used as temporary driving lanes.

In addition to the road types described above, the TEN-T (Trans-European Network - Transport) has some physically distinct sections, which set special requirements to road services including ITS. Such sections are:

- tunnels, bridges, sections with reversible lanes, interchanges, junctions of restricted capacity between different basic types of roads other sections with exceptional characteristics. These types of infrastructure can be inserted in a general category of "critical spots" (see following section) where not only traffic problems may exist, but also special services have to be applied.
- ferry connections within the road network. Even though the ferry connection parts are not likely to have the same ITS services as the surrounding road sections, for network continuity reasons the short ferry connection, which could be replaced by a bridge, should be given the same Operating Environment as the neighbouring road section(s). Longer ferry connections should be excluded.

8.2.2 Network typology or traffic management orientation

The road section concerned may also have a need for special service levels related to its role in the transport network. The roles important for the ITS service provision include:

- corridor: the road section is part of a long corridor connecting major cities and other key locations such as major ports including in total at least two alternative routes, of which at least one usually is a motorway. An additional requirement of a corridor is that the network or road operator manages the corridor as such at least in some of their network operation plans and schemes; i.e. if the road sections of the corridor are managed and operated (totally) independently of one another (except for using the alternative route for detour during incidents), the road sections are treated as links and spots.
- road/motorway network; grid of roads, motorways or a mix of roads and motorways. As above with corridors, the road sections in a network should be operated by traffic management and/or information tools as a network, and not only as totally independent elements. If the same road element is part of both a corridor and a network, the typology of road/motorway network is the recommended choice.
- peri-urban network; the road section is part of a motorway or road network integrating the TEN-T with the road/street network of major conurbations. Typically, a ring road round an urban area is a part of this kind of network.
- link: a road/motorway section connecting two locations (spot or a node of a network/road such as city, port, etc.) on the network while not constituting a part of a corridor or road/motorway nor peri-urban network in the traffic management sense. A location separating two links is sometimes an intersection or any other place on the road/motorway, where the characteristics of the road/motorway change in such a way that the Operating Environment or its attributes will

also change. This can happen for instance if the traffic volume suddenly increases or decreases drastically at an intersection, the road climate changes abruptly, etc.

— spot (or short stretch); a specific part of the road/motorway differing from the surrounding part of the road network (critical bends, uphill sections, tunnels, bridges, interchanges etc.) especially with regard to the need of specific ITS solutions. Note that all bends, uphill sections, tunnels, bridges, interchanges etc. do not need to be classified as spots if they are not considered as a specific problem location.

This typology is a basis for defining Operating Environments and assigning a letter code to each type. Traffic flows and safety (see next points) will provide further details (distinguished with numbers).

Note: that any section of the road/motorway can only belong to one typology. This is to ensure the summing up of the network lengths based on the Operating Environments.

8.2.3 Traffic flow impact

Note that both for traffic flow impact and safety concerns, the road section is treated as a whole, consisting of both driving directions, even though in some cases the conditions might vary from one direction to the other. Again, this is done to ensure correct summing up of network lengths. If, however, a road operator insists on treating the directions as separate, this is allowed as long as this treatment is carried out consistently in the whole network of the country in question and specifically reported.

The existence of traffic flow impact is related to the actual flow situation on the specific road section in terms of traffic volumes.

It is quite obvious that ITS service levels need to be linked to the volume of traffic and how it varies with time. We aim at specific quantitative thresholds for annual average daily traffic (AADT) to set up the categories for traffic flow impact. This is described accordingly:

— daily traffic related impact; recurring congestion problems can affect traffic almost each working day, and incidents may also be quite frequent. If AADT is on motorways at least 12,500 vehicles/day per lane (i.e. 50,000 on 2+2, and 75,000 on 3+3 lane motorway) and on other roads at least 9,000 vehicles/day per lane (i.e. 18,000 on a 1+1 and 36,000 on a 2+2 lane road), the road should always be in this category. If the number of lanes changes within the section, the lower lane number should be used when applying the traffic volume thresholds above.

— seasonal traffic related impact; severe traffic congestion can exist but only seasonally, for instance during weekends during vacation times and holidays. Note that the current Operating Environments do not explicitly address seasonal problems on motorway links. If such, however, exist, these roads should be included in the Operating Environments with daily problems.

— no traffic related impact; congestion and other flow-related problems are infrequent and are usually caused only by major incidents or events. If AADT is on motorways less than 6,000 vehicles/day per lane (i.e. 24,000 on 2+2, and 36,000 on 3+3 lane motorway) and on other roads less than 4,000 vehicles/day per lane (i.e. 8,000 on a 1+1 and 16,000 on a 2+2 lane road), the road should always be in this category.

Note that the thresholds above leave room for member states and road operators to use their own thresholds set according to national or road operator's own criteria. Naturally, local circumstances can also motivate deviation from the general principles and thresholds for specific road segments.

8.2.4 Potential road safety concerns

The existence of potential road safety concerns is related to the actual situation on the specific road section.

Two safety categories are to be used:
- potential safety concerns; accident rates are considered high or severe outcomes are expected from any crashes; this can be due to e.g. severe weather problems related to snow, ice, fog and/or strong cross-winds affect traffic considerably and frequently – especially in the wintertime. Other reasons for this classification may be high percentage of heavy traffic, existence of vulnerable road users at the road side, risk of severe consequences on isolated mountain roads, old fashioned or inadequate road design, etc.
- no major safety related concerns; problems considerably affecting road safety are only occasional and infrequent.

There are three methods used to identify a section with potential safety concerns:
1) Road sections, where the long-term (preferable at least five-year average) severe accident rate (accidents/100 million veh-km) is 30% higher than the national average,
2) Road sections, where the long-term fatality density (fatalities/100 road-km) is 30% higher than the national average, and
3) Road sections, where the EuroRAP rating is less than 3 stars (in scale 1-5).

The first method is recommended as the one most closely related to the safety experienced by the driver. Naturally, local circumstances can motivate deviation from the afore-mentioned methods and thresholds for specific road segments.

8.2.5 Other attributes

The actual Operating Environments are determined on the basis of the attributes listed above. In addition to these, the road operators may also voluntarily choose to use additional criteria for classifying their road network. Such additional attributes are most likely related to weather, environmental and heavy goods transport concerns. These attributes are elaborated upon below. No agreement on the method for classification of these other attributes has been reached so far.

8.2.5.1 Existence of weather problems

The road/motorway is classified as having critical weather-related problems, if severe weather problems related to snow, ice, fog, heavy rainfall and/or strong cross-winds considerably and frequently affect traffic - especially in the wintertime.

8.2.5.2 Existence of environmental concerns

The road/motorway section has critical environment concerns if it is passing through an area sensitive to environmental (pollution, noise) impact or affected by regulations such as groundwater areas, parks, residential areas, schools, playgrounds, etc.

8.2.5.3 Truck transport relevance

The link, corridor or network is of particular importance for freight transport. The proportion of heavy goods vehicles of all traffic or the average daily number of heavy goods vehicles are regarded as high by the road operator or the road/motorway is leading to a major logistics hub such as a port, airport (cargo), freight village etc.

8.3 Carrying out the classification in practice

8.3.1 Basic principles

This section describes how the road operators should classify their road networks into Operating Environments. The definition of what constitutes the network to be classified is decided by the road operator in question.

Note that if the road operator cannot classify a specific road section into any of the Operating Environment categories given in the document, the partner should choose the Operating Environment best fitting the specific road section, and to inform the authors of this document of the characteristics of all such sections poorly fitting into the current Operating Environments. Such cases will be considered when future versions of the Operating Environments are being proposed and when this classification guidance is being updated. It should be noted that the ultimate goal is to achieve a consistent European methodology for classifying the road network into Operating Environments.

The classification method proposed takes into account the possibility of a later integration of the Operating Environment classification with a map-tool, allowing for network classification to be displayed in a map.

In practice, it seems to be easier to classify road networks into Operating Environments criteria by criteria, as often each criterion is best dealt with by a specific expert. A congestion expert can easily classify the network by traffic flow impact, whereas another expert on safety will quickly classify the whole network according to the existence of potential safety concerns.

The whole relevant road network is to be classified. For the classification, the network is to be divided into sections according to the basic factors determining the Operating Environment – physical layout, network typology, traffic flow impact and potential safety concerns as well as the additional attributes (weather, environment, freight), which the road operator chooses to use. This means that a new section could start each time, when the category of at least one of these factors and attributes changes. This may result in road sections of very varying length (from hundreds of metres to hundreds of kilometres). The road operators may also cut the sections also at other points, according to their own uses and preferences. The general recommendation is to use motorway exits and major road junctions as the points of division for the road network, because this will simplify some later procedures such as map-matching. Hence, a road section normally runs from one exit/junction to another, but not necessarily the next one.

Naturally, road characteristics, traffic flow and road safety conditions evolve over time partly due to ITS deployments. Hence, the need to update the Operating Environment classification should be assessed at regular intervals.

8.3.2 Using the Excel support tool

An efficient way of carrying out the classification is to use an Excel tool for this. The road network is filled in into the Excel workbook road by road and motorway by motorway, section by section. All network elements classified should include official names (junction names, road names and/or TMC location codes if available) since this simplifies the matching of elements for various applications and supports error detection and quality management in general. The worksheet has the following columns:

— Identification number of the road network element (e.g. reference to a map element to be introduced in an optional folder or sheet; to make the numbering unique, nation codes such as DE, FI, SE etc. are recommended to precede the actual numbers)
— Name of road/motorway (e.g. E18, according to the member state naming convention)
— Start of section (distance from start of road/coordinate/location description)
— End of section (distance from start of road/coordinate/location description)
— Length of section (km, 0-3 decimals)
— Physical characteristics,
— Network typology or traffic management orientation
— Existence of potential safety concerns (0=no, 1=yes)
— Existence of traffic impact (0=no, 1=seasonal, 2=daily)
— Existence of weather problems (0=no, 1=yes); W (optional)
— Existence of environmental concerns (0=no, 1=yes); E (optional)
— Truck relevance (0=no, 1=yes); T (optional)
— Operating Environment: this is automatically determined through a macro utilising the combination of physical layout, typology and existence of traffic flow and safety concerns and to be accompanied with the weather, environment and truck relevance attributes

The other columns of the worksheet can be used for describing the coverage (%) of the road/motorway section with different core ITS services of specific service levels, or e.g. the values of the deployment indicators during a year or a project phase. The excel sheet can also be used as direct input to a map or other ways of reporting the classification.

The empty Excel worksheet for the classification is presented in Figure C-1. An example of a filled excel sheet is given in Figure C-2.

Figure C-1: **A screenshot of the excel worksheet for classification of road network into Operating Environments.**

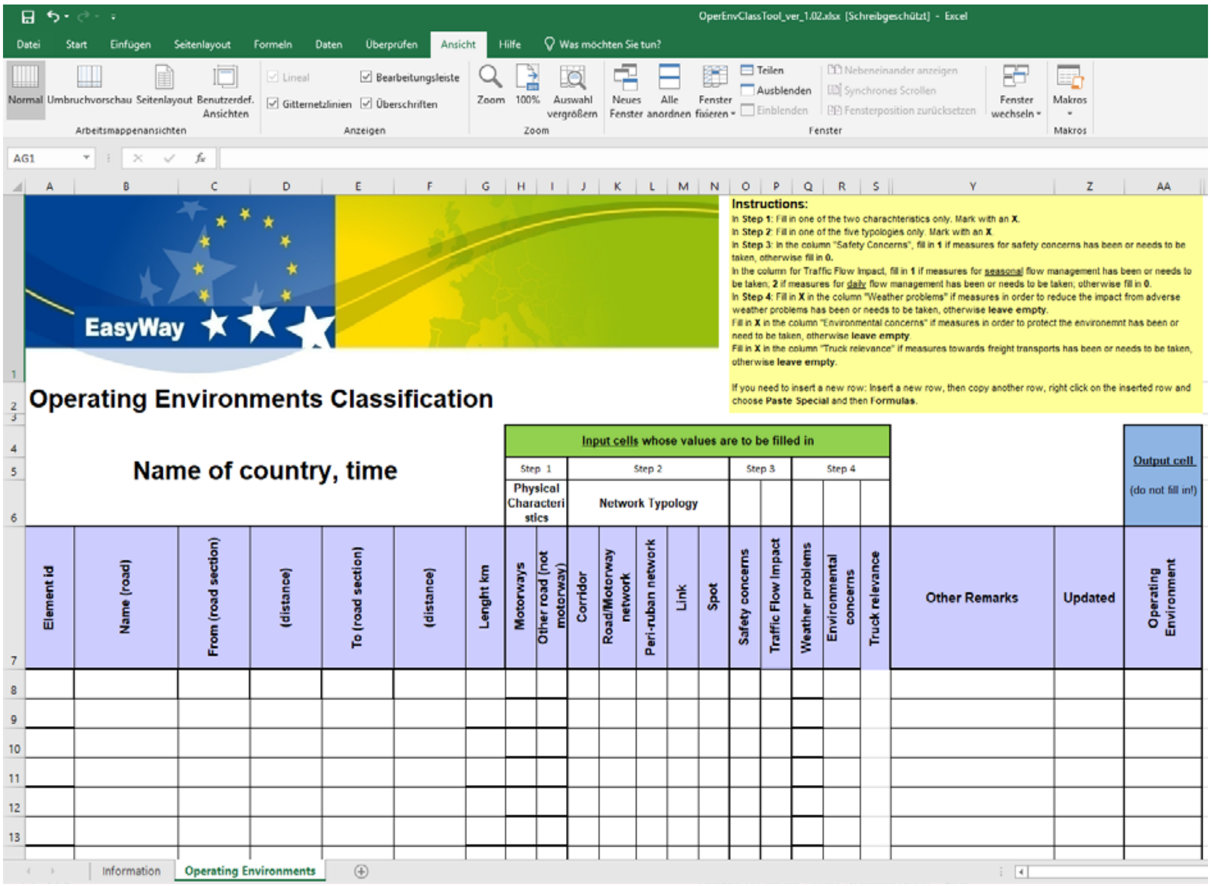


Figure C-2: **Example of the contents of the excel worksheet for classification of road network into Operating Environments. Note that for map use, the start and the end points should be indicated by specific map attributes such as e.g. coordinates.**

					Input cells whose values are to be filled in															Output cell
					Step 1			**Step 2**						**Step 3**		**Step 4**				
					Physical characteristics			Network Typology												
Element id	Name	From	To	Length km	Motorways	Two-lane roads	Three/Four lanes roads	Corridor	Road/Motorway network	Peri-urban network	Link	Spot	Safety concerns	Traffic Flow impact	Weather problems	Environmental concerns	Truck relevance	Other remarks	Updated	Operating Environment
F001	E18	Helsinci entrance	Ring I	3,2														Example		C1
F002	E18	Ring I	Ring III	8,4														Example		P1
F003	E18	Ring III	Lohja	41,3														Example		S1
F004	Ring III	VT51	E18	9,8														Example		S1
F005	Ring III	Rovaniemi	Norway	368,0														Example		R4-W

8.4 Reporting the classification

There are two main ways to report the classification in addition to the use of the Excel document as the final outcome. The target should be to connect the report directly to the classification of the Operating Environments either in the Excel tool so that the reports are more or less automatically generated after the data from the road network has been properly filled in.

The first way of reporting is to use a map and geographic information system (GIS). The choice of the mapping software should comply with the mapping requirements of the overall deployment monitoring and reporting requirements related to the ongoing situation of the road operator.

The second way is to report the lengths of each Operating Environment, and this can be carried out on the basis of the Excel worksheet. This is useful for the deployment target setting and deployment monitoring purposes. An example is given in Table C-1 below.

Table C-1: **Example of Operating Environment classification summary report.**

Operating Environment	Finland Km
C1 critical spots, local flow-related traffic impact and/or potential safety concerns	11
T1 motorway (link), no flow-related traffic impact and no major safety concerns	314
T2 motorway (link), no flow-related traffic impact, potential safety concerns	249
T3 motorway (link), daily flow-related traffic impact, no major safety concerns	11
T4 motorway (link), daily flow-related traffic impact, potential safety concerns	126
R1 road (link), no flow-related impact, no major safety concerns	2194
R2 road (link), no flow-related traffic impact, potential safety concerns	1151
R3 road (link), seasonal or daily flow-related traffic impact, no major safety concerns	0
R4 road (link), seasonal or daily flow-related traffic impact, potential safety concerns	10
S1 motorway corridor or network, at most seasonal flow-related impact, possibly safety concerns	0
S2 motorway corridor or network, daily flow-related traffic impact, possibly safety concerns	0
N1 road corridor or network, at most seasonal flow-related traffic impact, possibly safety concerns	0
N2 road corridor or network, daily flow-related traffic impact. possibly safety concerns	0
P1 peri-urban motorway or road interfacing urban environment, possibly safety concerns	61
Total	4040

It is also essential that the road operator describes in detail how they have made the classification into Operating Environments, if their own method of classification differs from the one proposed in these guidelines. This is crucial as the ultimate goal is to arrive at a common and consistent classification in Europe. In order to reach a consensus, it is essential that all involved understand the routines and cultures applied by each partner and their reasons for such ways of applications.

If the classification is reported with another map tool, the same colours should be used in the map tools utilised. These colours are the standard HTML colours indicated in Figure C-2.

Table C-2: **The colour scheme to be used for the Operating Environments in the maps.**

OE	Colour (html)	HEX	RGB
C1	Black	000000	0,0,0
T1	LightSalmon	FFA07A	255,160,122
T2	DarkOrange	FF8C00	255,140,0
T3	OrangeRed	FF4500	255,69,0
T4	FireBrick	B22222	178,34,34
S1	Yellow	FFFF00	255,255,0
S2	Gold	FFD700	255,215,0
P1	MidnightBlue	191970	25,25,112
R1	YellowGreen	9ACD32	154,205,50
R2	ForestGreen	228B22	34,139,34
R3	DarkGreen	006400	0,100,0
R4	DarkSlateGray	2F4F4F	47,79,79
N1	DarkOrchid	9932CC	153,50,204
N2	MediumVioletRed	C71585	199,21,133

List of Weblinks

Chapter	Description	Web address
1.2.2	Directive 2010/40/EU	https://ec.europa.eu/transport/themes/its/road/action_plan_en
1.2.2	Delegated Regulation 885/2013 on the provision of information services for safe and secure parking places for trucks and commercial vehicles	http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R0885&from=EN
1.2.2	Delegated Regulation 886/2013 on the provision of road safety-related minimum universal traffic information free of charge to users	https://eur-lex.europa.eu/eli/reg_del/2013/886
1.2.2	Delegated Regulation 2015/962 on the provision of EU-wide real-time traffic information services	http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015R0962&from=EN
1.2.2	Delegated Regulation 2017/1926 on the provision of EU-wide multimodal travel information services	https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017R1926&from=EN
1.2.4	Delegated Regulation 886/2013 on the provision of road safety-related minimum universal traffic information free of charge to users	https://eur-lex.europa.eu/eli/reg_del/2013/886
1.2.4	Monitoring and Harmonisation of National Access Points	https://www.its-platform.eu/achievement/monitoring-harmonisation-of-NAP
1.2.4	National Access Points A mechanism for accessing, exchanging and reusing transport related data under Delegated Acts of the ITS Directive (2010/40/EU)	https://ec.europa.eu/transport/sites/transport/files/its-national-access-points.pdf
1.2.5	Rules of Procedure of the DATEX II organization	https://datex2.eu/sites/default/files/2018-09/20170612_DATEX_II_-_Rules_of_Procedure_DATEX_II_CEF_CEDR_Final_version_1.0.pdf
1.2.6	Release 2.0 of C-Roads harmonised C-ITS specifications	https://www.c-roads.eu/platform/about/news/News/entry/show/release-16-of-c-roads-harmonised-c-its-specifications.html
2.4	RFC 2119	https://www.ietf.org/rfc/rfc2119.txt
2.5.1	Safety related message sets – Selection of DATEX II Situations, DENM and TPEG2-TEC Causes and TMC Events for EC high level category	https://datex2.eu/sites/default/files/2021-04/ITSTF20001_SafetyrelatedMessage-Sets-DATEXII_DENM_TPEG-TEC_TMC_%20v1.5_FINAL.pdf
3.2.2.1.2	Quality Package defined in EU-EIP Activity 4.1	https://www.its-platform.eu/filedepot/folder/1134?fid=6521
3.2.2.7.1	Quality of S Real-Time Services - Quality package	https://www.its-platform.eu/highlights/update-eu-eip-quality-package-srti-and-rtti
3.3.2.7.1	Quality of S Real-Time Services - Quality package	https://www.its-platform.eu/highlights/update-eu-eip-quality-package-srti-and-rtti
3.5.2.7.1	Quality of S Real-Time Services - Quality package	https://www.its-platform.eu/highlights/update-eu-eip-quality-package-srti-and-rtti
3.6.2.7.2	Quality of S Real-Time Services - Quality package	https://www.its-platform.eu/highlights/update-eu-eip-quality-package-srti-and-rtti
5.2.2.5	ITS Action Plan – Priority Actions E and F - Information and Reservation Services for Safe and Secure Parking Places for Trucks and Commercial Vehicles - Final Report	https://ec.europa.eu/transport/sites/transport/files/themes/its/studies/doc/20121219_itsap_prioef_final_report.zip

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