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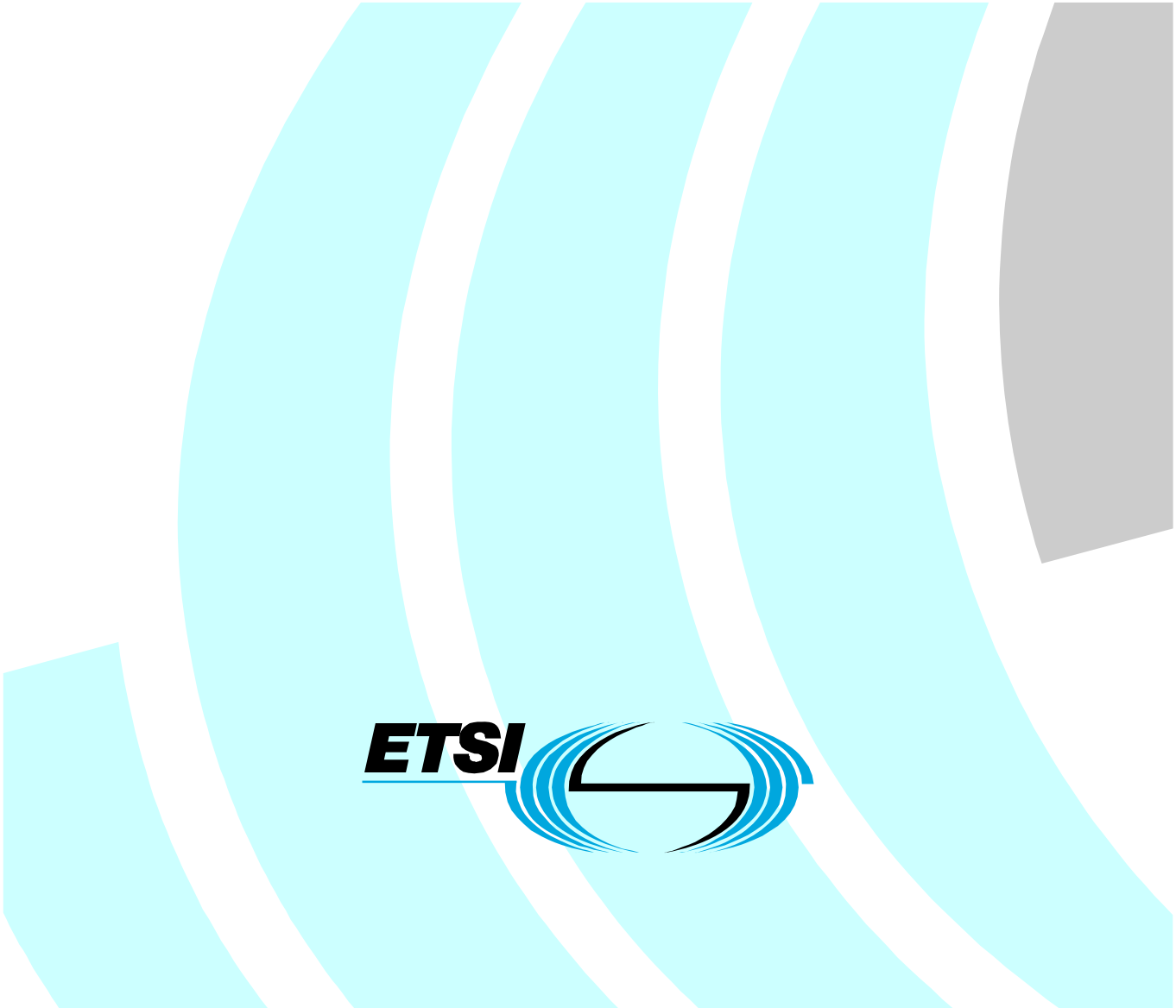
Technical Report

Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Local Dynamic Map (LDM); Rationale for and guidance on standardization



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Contents

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Intelligent Transport System (ITS).

Introduction

In co-operative Intelligent Transport Systems (ITS), the Local Dynamic Map (LDM) is a key facility element which supports various ITS applications by maintaining the information on objects influencing or being part of traffic. The Local Dynamic Map therefore is relevant to the development of technical standards and specifications in order to ensure deployment and interoperability of co-operative systems and services in the EC's 2009 ICT Standardisation Work Programme.

The ITS architecture [i.2] identifies the LDM to be a key function within the ITS station facilities layer. Co-operative Awareness Messages (CAMs) [i.1] and Decentralized Environmental notification Messages (DENMs) [i.6] are important sources of data for the LDM. Moreover, a Basic Set of Applications (BSA) [i.3] is defined, which can be realistically deployed in a time frame of about 3 years after the end of their standardization. This contains several classes of applications which make use of information stored in the LDM. These applications are:

- Driving assistance - Co-operative awareness.
- Driving assistance - Road Hazard Warning.
- Speed management.
- Co-operative navigation Location based services.
- Communities services.
- ITS station life cycle management.

1 Scope

The present document provides guidance on Local Dynamic Map (LDM) standardization based upon an analysis of the needs for standards for Intelligent Transport Systems (ITS).

The objective of the present document is to identify and characterize the elements of the LDM to be standardized to ensure interoperability between distributed applications and to provide applications support. It is also to identify and characterize the interfaces between the LDM, the other facilities functions and the distributed application elements which need to be standardized.

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

NOTE: While any hyperlinks included in this clause were valid at the time of publication ETSI cannot guarantee their long term validity.

2.1 Normative references

The following referenced documents are necessary for the application of the present document.

Not applicable.

2.2 Informative references

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI TS 102 637-2 (V1.1.1):"Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 2: Specification of Co-operative Awareness Basic Service".

[i.2] ETSI EN 302 665: "Intelligent Transport Systems (ITS); Communications Architecture".

[i.3] ETSI TR 102 638 (V1.1.1): "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Definitions".

[i.4] UNECE Recommendations on the Transport of Dangerous Goods - Model Regulations; Twelfth revised edition (2001).

[i.5] UNECE Convention On Road Signs And Signals; Amendment 1; Vienna 1968.

[i.6] ETSI TS 102 637-3: "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 3: Specifications of Decentralized Environmental Notification Basic Service".

[i.7] TPEG TEC: "TISA Specification SP09006 - Traffic and Travel Information (TTI) - TTI via Transport Protocol Expert Group (TPEG) binary data format - Part 9: Traffic Event Compact application".

[i.8] EC CVIS Project Deliverable 3.4: "Final Architecture and System Specification".

[i.9] EC SAFESPOT Project Deliverable 3.5.4: "Key Concepts And Exploitation version 1.2".

[i.10] ETSI TR 102 762: "Human Factors (HF); Intelligent Transport Systems (ITS); ICT in cars".

[i.11] CAR 2 CAR Communication Consortium (2007): "Manifesto; Overview of the C2C-CC System".

[i.12] EC COOPERS Project deliverable WP3000 (2010):"Services and value chains, concerning operator/ user behaviour; Integration of services in the co-operative system".

[i.13] ISO 17572-3:2008: "Intelligent transport systems (ITS) -- Location referencing for geographic databases -- Part 3: Dynamic location references (dynamic profile)".

[i.14] OpenLR White Paper Version 1.3 (05.2010): "An open standard for encoding, transmitting and decoding location references in digital maps".

[i.15] ETSI TS 102 637-1: "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 1: Functional Requirements".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in EN 302 665 [i.2] and the following apply:

Local Dynamic Map (LDM): conceptual data store which is embedded in an ITS station and which contains topographical, positional and status information related to ITS stations within a geographic area surrounding the host station

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

API	Application Program Interface
BSA	Basic Set of Applications
CA	Co-operative Awareness
CAM	Co-operative Awareness Message
CN	Co-operative Navigation
COOPERS	CO-OPERative systems for intelligent road Safety
CS	Communities Service
CSM	Co-operative Speed Management
CVIS	Co-operative Vehicle-Infrastructure Systems
DENM	Decentralized Environmental Notification Message
FA	Facilites/Applications
ICT	Information and Communication Technology
ITS	Intelligent Transport System
LBS	Location-Based Service
LCM	Life Cycle Management
LDM	Local Dynamic Map
MF	Management/Facilities
NF	Networking&Transport/Facilities
POI	Point Of Interest
RHW	Road Hazard Warning
RSU	Road Side Unit
SAP	Service Access Point
SF	Security/Facilities
TPEG	Transport Protocol Experts Group
V2I	Vehicle to Infrastructure
V2V	Vehicle to Vehicle
WLAN	Wireless Local Area Network

4 General description of a LDM

4.1 The LDM

Information about the local environment is essential in co-operative ITS systems. ITS applications require information both on moving objects such as other vehicles nearby and on stationary objects such as traffic road signs. Common information required by different applications can be maintained in a local dynamic map.

The Local Dynamic Map (LDM) is a conceptual data store located within an ITS station [i.2] containing information which is relevant to the safe and successful operation of ITS applications. Data can be received from a range of different sources such as vehicles, infrastructure units, traffic centres and on-board sensors as shown in Figure 1. Read and write access to data held within the LDM is achieved using an interface. The LDM offers mechanisms to grant safe and secure data access. Thus the LDM is able to provide information on the surrounding traffic and RSU infrastructure to all applications that require it.

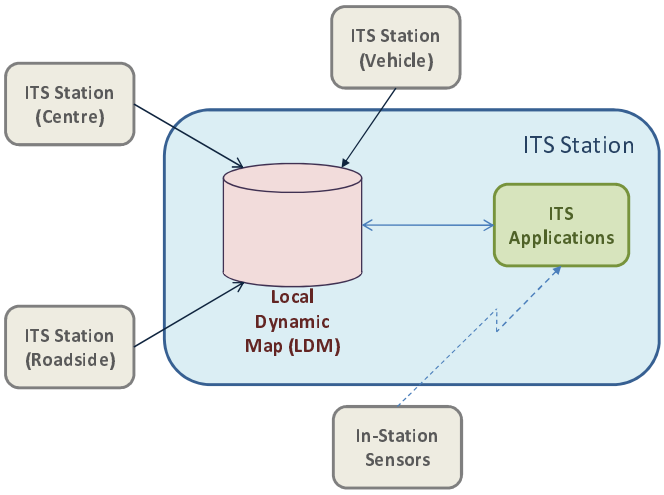

Figure 1: Relationship between LDM and its information sources

The LDM contains information on real-world and conceptual objects that have an influence on the traffic flow. The LDM is not required to maintain information on the ITS station it is part of but may do so if necessary in a particular implementation.

Data describing real world objects can be categorized in four different types as follows:

- Type1: permanent static data, usually provided by a map data supplier.
- Type 2: transient static data, obtained during operation, e.g. changed static speed limits.
- Type 3: transient dynamic data, e.g. weather situation, traffic information.
- Type 4: highly dynamic data, e.g. CAM.

The LDM will not contain type 1 data. Not all ITS stations require type 1 data. In case type 1 data are needed by an application within an ITS system (e.g. a navigation application), these data will be optimised and stored for the respective specific application. It is currently not feasible to define one common map data format and specify the required standard interfaces to access these data that meet the requirements for all ITS stations.

NOTE: Further study is required to determine how accurate local digital mapping information can be received, stored and provided by the LDM for applications which would benefit by having such information available.

As the LDM data are potentially relevant for applications that make use of type 1 data, the location referencing data that are required for relating type 2, type 3 and type 4 information to the type 1 map data should be provided. This location referencing is a complex operation and requires adequate location referencing methods. As not all ITS applications that potentially use LDM require location referenced information, the use of these data is not mandatory.

4.2 The position of the LDM within the ITS architecture

4.2.1 ITS system overview

Co-operative ITS systems [i.2] include vehicle-to-vehicle, vehicle-to-infrastructure and infrastructure-to-infrastructure communications for the exchange of information. Figure 2 shows the participants in the ITS communication architecture and a selection of ITS applications. These applications provide driver assistance (active road safety) or driver information (co-operative traffic efficiency) functionality.

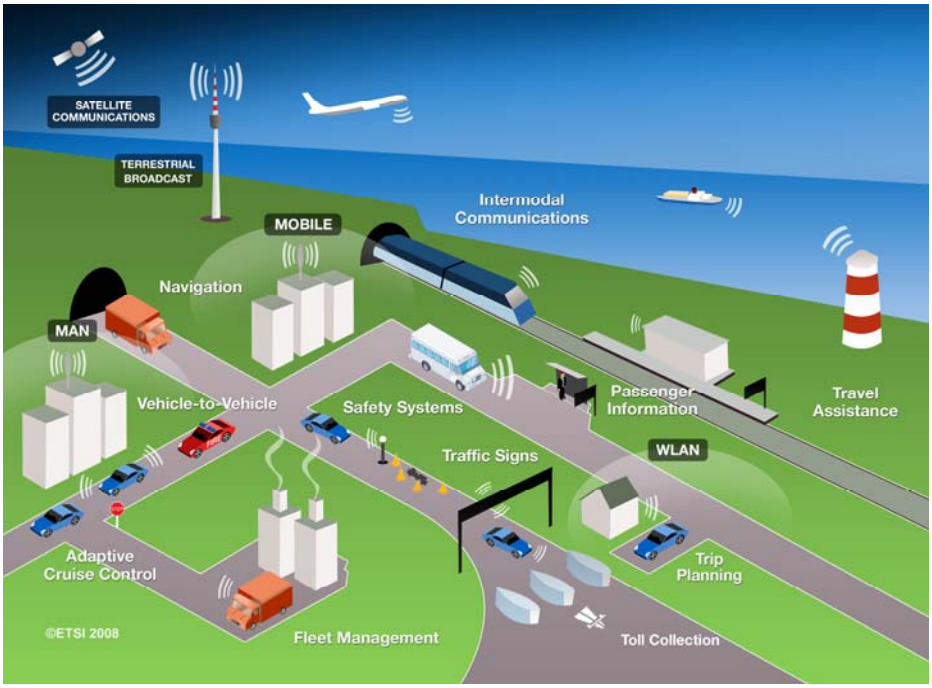

Figure 2: ITS system overview

4.2.2 ITS station reference architecture

ITS stations that are part of road side infrastructure differ from Vehicle ITS stations only in their connected sensors. Road side equipment can rely on more dedicated sensors such as induction loops and video that are part of the road network infrastructure.

Within the current ITS station reference architecture [i.2], the LDM is part of the facilities layer and covers information and application support.

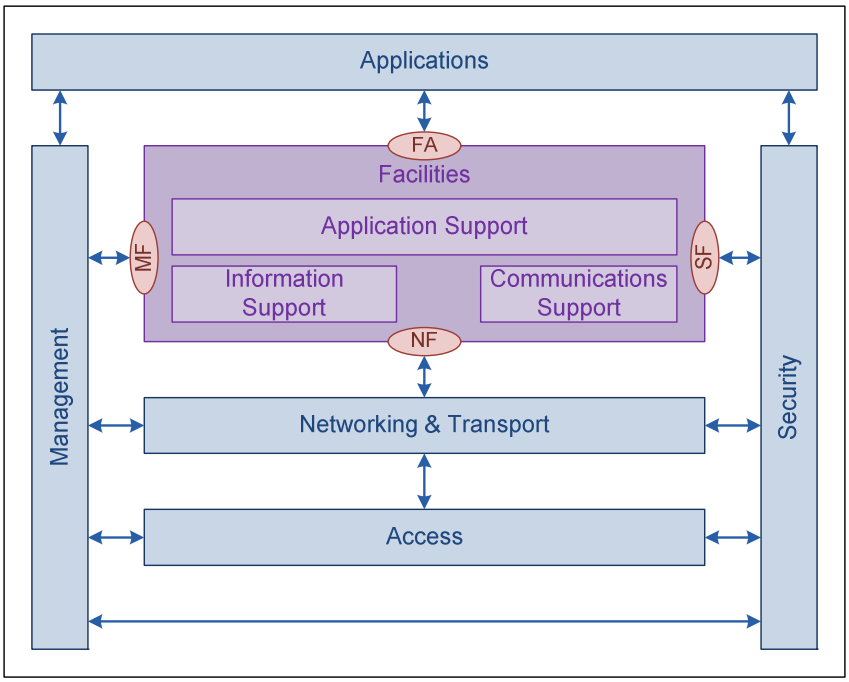

Figure 3: ITS station reference architecture [i.2]

4.2.3 ITS facilities layer architecture

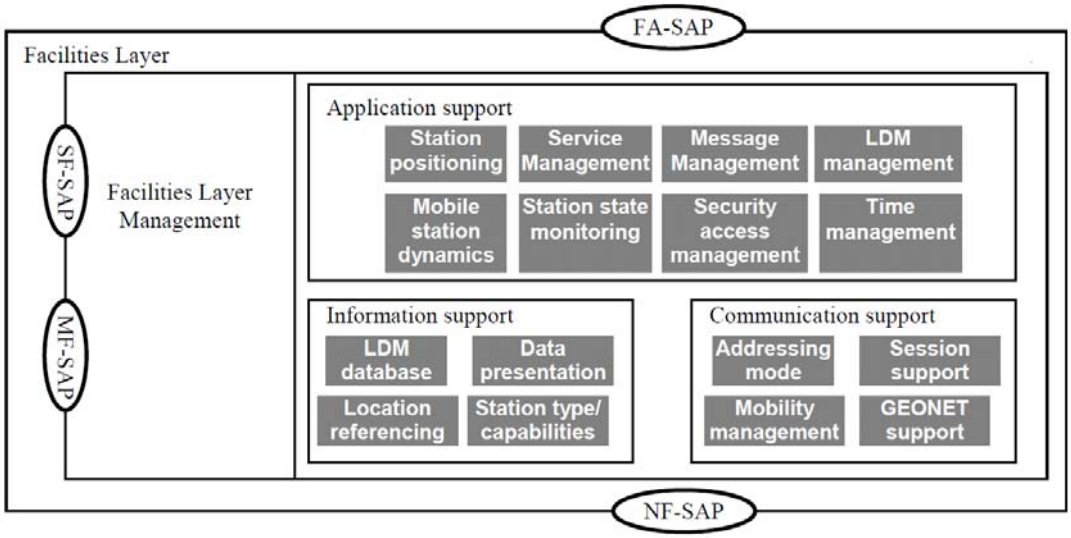

Figure 4: ITS Application/Facilities overview

Details of the facilities layer are presented in Figure 4. Recommendations regarding further refinement of the facilities layer to meet the requirements of the LDM can be found in clause 8.

5 Analysis of ITS applications

The analysis of ITS applications is based on following applications:

- Driving assistance -Co-operative awareness (CA).
- Driving assistance - Road Hazard Warning (RHW).
- Co-operative speed management (CSM).
- Co-operative navigation (CN).
- Location based services (LBS).
- Communities services (CS).
- ITS station life cycle management (LCM).
- Transport related electronic financial transactions (road tolls).

Each application contains one or more use cases. All use cases - including a short description and their origin are provided in Table A-1 in Annex A.

5.1 ITS applications analysis: information elements

Information held in the LDM can be classified into four distinct types (clause 4.1) as specified in the following tables:

- Type 1: permanent static data (Table 1) usually provided by a map data supplier:
  - includes information about the road topography, road attributes (such as speed limits and functional road class) and points of interests. It describes static information on real world objects.

Table 1: Examples of Type 1 Data (Permanent Static)

Local road topography	
Lane precise local road topography	
Position of permanent local point of interest (POI) and services (including public car parks)	Name
	Type
	Location information
	Total Number of Parking Spaces
	Park & Walk or Park & Ride
Position of local toll collection points	Name
	Location information
	Direction
Statutory speed limit descriptor	Location information
	Direction
	Speed

- Type 2: transient static data (Table 2) obtained during operation:

  - includes information about roadside infrastructure such as position of gantries and traffic signs. It describes information of the real world with a quasi static behaviour.

Table 2: Examples of Type 2 data (transient static)

Traffic signals and traffic signs	Location information of signals and signs
Position and meaning of new signs not in the pre-loaded map data.	Location information of road sign
	Type
	Sign parameters
Position of new points of interest (POI) and services (including public car parks)	Name
	Type
	Location information
	Total Number of Parking Spaces
	Park & Walk or Park & Ride
Toll charge for each collection point	

- Type 3: transient dynamic data (Table 3):

  - includes information about road works such as position, lane width, speed limits and incidents. It describes information of the real world with a dynamic behaviour having influence on traffic efficiency.

Table 3: Examples of Type 3 data (transient dynamic)

Location and dimensions of road works	Location information
	Direction affected
	Speed Limitations
Temporary speed limit descriptor	Location information
	Direction
	Speed
Current status of traffic signals	Phase currently facing host vehicle
Location and dimensions of hazard (including stationary vehicle and weather conditions)	Location information of Hazard
	Identity of Lane affected
	Hazard Type
	Propagation Range of Hazard Report
	Propagation Direction of Hazard Report
	Current Status of Hazard (active, cleared...)
Temporary changes in lane or road direction restrictions	Lane identifier
	Restriction Type
	Direction of traffic flow
	Speed limitation
	Location information
Designed progression speed through linked traffic signals.	Location information of linked signals
	Direction of traffic flow
	Progression speed
Position of temporary points of interest (including public car parks)	Name
	Type
	Location information
	Total Number of Parking Spaces
	Park & Walk or Park & Ride
Current status of all permanent and temporary local parking facilities	Open/Closed status
	Number of free spaces/percentage full
Position and meaning of temporary signs not in the pre-loaded map data.	Location information of road sign
	Type
	Sign parameters

- Type 4: highly dynamic data (Table 4):

  - includes information about ITS stations within the vicinity such as vehicles and dynamic traffic signs. It describes information of the real world with a highly dynamic behaviour having mainly influence on traffic safety and some influence on traffic efficiency.

Table 4: Examples of Type 4 data (dynamic)

Current speed, position and direction of all ITS Stations within range of the host	Pseudonym
	Vehicle Type
	Current status
	Speed
	Direction
	Location information
	Lane occupied

A more complete analysis of the four types of data held in the LDM can be found in Table A-2 in Annex A.

5.2 ITS applications analysis: functionality

The LDM is located within the ITS facilities layer and therefore aims to provide functionality which several applications require to function. Table 5 identifies the individual requirements of the BSA use cases from the LDM.

Several applications can benefit from dynamic information that is referenced to a static digital map of the road network (Annex A). It is not feasible to specify an LDM that includes a full static digital map for the following reasons:

- navigation systems are based on proprietary map memory formats;
- it is unlikely that there will be two separate instances of a static digital map within early implementations of an ITS station; and
- the basic LDM functionality should work independently of the used map instance.

Map referencing requirements are, therefore, not considered further here.

Table 5: Relevant functionality by each use case

Use case	Description	Relevant functionality
UC_CA_01	Emergency vehicle warning	Access to CAM, notification, plausibility check
UC_CA_02	Slow vehicle indication	Access to CAM, notification, plausibility check
UC_CA_03	Across traffic turn collision risk warning	Access to CAM/DENM, notification, plausibility check, low latency
UC_CA_04	Merging Traffic Turn Collision Risk Warning	Access to CAM/DENM, notification, plausibility check, low latency
UC_CA_05	Co-operative merging assistance	Access to CAM, plausibility check, notification, low latency, distinguishing identifiers for each vehicle
UC_CA_06	Intersection collision warning	Access to CAM/DENM, notification, plausibility check, low latency, distinguishing identifiers for each vehicle
UC_CA_07	Co-operative forward collision warning	Access to CAM/DENM, plausibility check, notification, low latency, distinguishing identifiers for each vehicle
UC_CA_08	Lane Change Manoeuvre	Access to CAM history, plausibility check, notification, low latency, distinguishing identifiers for each vehicle
UC_RHW_01	Emergency electronic brake lights	Access to DENM/CAM history, plausibility check, notification, low latency, distinguishing identifiers for each vehicle
UC_RHW_02	Wrong way driving warning (infrastructure based)	Access to DENM/CAM history, plausibility check, notification,
UC_RHW_03	Stationary vehicle - accident	Access to DENM, plausibility check, notification
UC_RHW_04	Stationary vehicle - vehicle problem	Access to DENM, plausibility check, notification
UC_RHW_05	Traffic condition warning	Access to DENM, plausibility check, notification
UC_RHW_06	Signal violation warning	Access to DENM/CAM history, plausibility check, notification, low latency, distinguishing identifiers for each vehicle

Use case	Description	Relevant functionality
UC_RHW_07	Roadwork warning	Access to DENM, plausibility check, notification
UC_RHW_08	Decentralized floating car data - Hazardous location	Access to DENM/CAM history, plausibility check, notification, low latency, distinguishing identifiers for each vehicle
UC_RHW_09	Decentralized floating car data - Precipitations	See UC_RHW_08
UC_RHW_10	Decentralized floating car data - Road adhesion	See UC_RHW_08
UC_RHW_11	Decentralized floating car data - Visibility	See UC_RHW_08
UC_RHW_12	Decentralized floating car data - Wind	See UC_RHW_08
UC_RHW_13	Vulnerable road user Warning	Access to CAM history, notification, plausibility check
UC_RHW_14	Pre-crash sensing warning	Access to DENM/CAM history, plausibility check, low latency, distinguishing identifiers for each vehicle
UC_RHW_15	Co-operative glare reduction	Access to CAM, plausibility check, notification
UC_CSM_01	Regulatory / contextual speed limits notification	Access to DENM/TPEG, plausibility check, notification
UC_CSM_02	Curve Warning	Access to CAM history/DENM/TPEG, plausibility check, notification
UC_CSM_03	Traffic light optimal speed advisory	Access to DENM, plausibility check, notification
UC_CN_01	Traffic information and recommended itinerary	Access to relevant information including shared information from other applications
UC_CN_02	Public transport information	Access to relevant information
UC_CN_03	In-vehicle signage	Access to DENM/TPEG, plausibility check, notification
UC_LBS_01	Point of Interest notification	Access to relevant information, plausibility check, notification
UC_LBS_02	Automatic access control and parking management	Access to relevant information, plausibility check, notification
UC_LBS_03	ITS local electronic commerce	No relevance to LDM
UC_LBS_04	Media downloading	No relevance to LDM
UC_CS_01	Insurance and financial services	No relevance to LDM
UC_CS_02	Fleet management	No relevance to LDM
UC_CS_03	Loading zone management	Access to relevant information, plausibility check, notification
UC_CS_04	Theft related services/After theft vehicle recovery	Access to relevant information, plausibility check, notification
UC_LCM_01	Vehicle software / data provisioning and update	No relevance to LDM
UC_LCM_02	Vehicle and RSU data calibration.	Access to relevant information, plausibility check, notification

5.3 Evaluation

ITS applications need to process static, temporary and dynamic data from other ITS stations in the surrounding area of the host station (vehicle and roadside). Relevant data needs to be stored and maintained in the LDM. The information in the LDM is received from relevant messages such as ITS CAM messages [i.1], DENM messages [i.1] and TPEG messages [i.6] and [i.7]. Since the contents of these messages are used by several applications, the plausibility and authorization checks are recommended to be done directly by the LDM.

Upon request from a specific ITS application, the required objects need to be extracted and passed directly to the appropriate application(s) where they are processed. For reasons of efficiency, a notification mechanism which provides an application with new information under certain application-defined trigger conditions could be provided by the LDM. Applications require mechanisms to update the LDM by storing processed information on the required objects back into the LDM so that it can be made available to other applications.

The method of updating LDM information is an implementation issue and, thus, not part of the present document.

Host information such as vehicle internal sensor data will not be available in the LDM.

6 LDM requirements and architecture

In order to enable applications and other parts of the ITS communications architecture to interact with the LDM in a uniform manner an API should be standardized. This enables 3rd party suppliers of ITS applications to access the information held in the LDM on a simplified and consistent basis.

6.1 LDM functional requirements

Functional requirements specify internal LDM functions that may communicate with other parts of the ITS communications architecture [i.2]. These functions include:

- receive incoming information such as DENMs, CAMs and TPEG messages and perform plausibility checks on the information that they contain;
- store and protect relevant information for required time;
- provide accurate information to authorized applications as requested and in a timely manner:
  - by means of a subscription/notification method; and
  - by means of queries including spatial queries.
- enable applications to store and protect processed information in order to share their results with other applications.

6.2 LDM non-functional requirements

In addition to the essential functional requirements, an LDM may also be constrained by a range of non-functional requirements, such as reliability (system maturity, fault tolerance and restorability) and scalability. However, within communications systems such requirements are normally considered to be related to procurement and consequently, not included in standardization.

NOTE: It may be necessary to consider the reliability of an ITS station in general (and the LDM in particular) as a potential regulatory requirement supported by European standardization.

6.3 LDM architecture

The ITS reference architecture [i.2] specifies two main components of the LDM:

- LDM Management; and
- the Data Store.

The LDM internal architecture can be extended as shown in Figure 5.

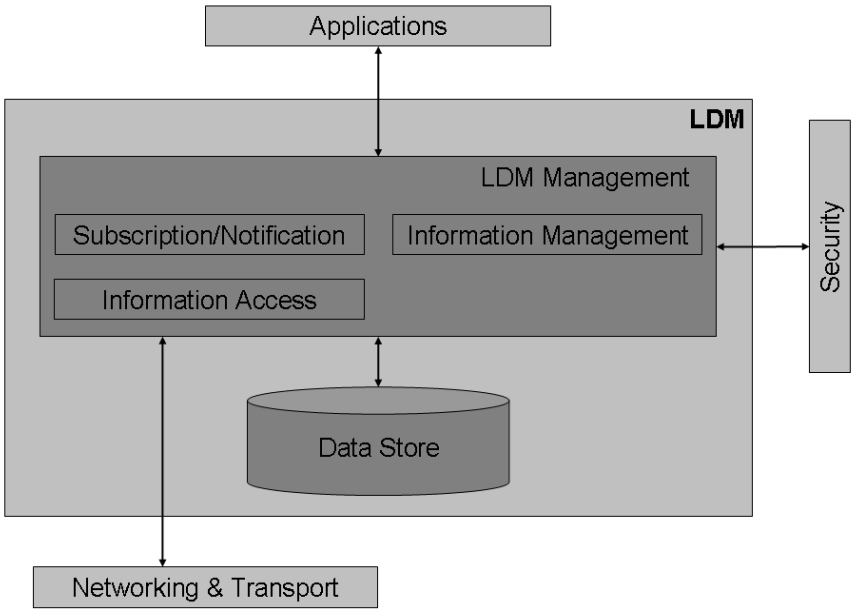

Figure 5: LDM architecture

The specified functionality is provided by the following modules within LDM Management:

- Subscription/Notification module;
- Information Management module; and
- Information Access module.

Each module performs, at least, the specific functions listed below:

- Subscription/Notification functional roles:
  - handling subscription/un-subscription requests for notification coming from applications;
  - filtering mechanisms to allow an application specific subscription to information. Properties upon which filtering can be based may include:
    - message source;
    - message type;
    - spatial criteria (for example, distance of source from the ITS station);
    - message count;
    - object dynamics (moving or static);
    - object direction;
    - object age; or
    - a combination of properties.
  - sending notification to the subscribed application. When an event triggers the required notification, it is transmitted to the requested application;
  - providing requested information together with a notification.

- Information Management functional roles:
  - receiving information from CAM, DENM or TPEG messages;
  - storing received and validated information in the LDM data store;
  - handling LDM maintenance:
    - discards irrelevant or corrupted information;
    - performs regular cleanup operations on the data store according to the data management rules that are set by the ITS station or by the applications.
  - handling application requirements: applications can set information relevance rules in the LDM management module. An example of such a relevance rule is that information from sources that are more than one kilometre away are to be discarded.
- Information Access module functional roles:
  - receiving requests from application information;
  - decoding and filtering information requests by type, location and other criteria (frequency, priority, etc.);
  - ensuring that security constraints are obeyed;
  - retrieving information from the LDM data store; and
  - passing back information to the requesting application.

LDM Management components interact directly with the Data Store using the following actions:

- storing relevant information;
- supporting insertion, update and delete functions.

Furthermore, LDM Management interacts with Applications, Security and Communication Support layers.

Applications layer roles which are LDM access related:

- subscribe to notification services that are offered by the Subscription/Notification functional entity;
- process the retrieved information and, potentially, write the result back in the LDM so that other applications can access the processed information;
- set the LDM management rules for managing information that is written in the LDM by the application.

6.4 LDM API

6.4.1 Introduction

The LDM has three main interfaces:

- LDM - FA-SAP (Applications);
- LDM - NF-SAP (Networking); and
- LDM - SF-SAP (Security).

The FA- and NF-SAP interfaces are both used for data transport, the SF-SAP is only used for authorisation operations. The following recommendations can only be considered to be an initial, basic set. Further refinement is needed once the requirements from the respective applications using the LDM are specified.

6.4.2 LDM - NF-SAP

The LDM - NF-SAP interface connects LDM to the ITS station communication functions. It allows the LDM to have access to incoming CAM, DENM and TPEG messages and other traffic related information.

The LDM does not provide messages to the communication functions.

It is assumed that the source of any incoming information will be authenticated, if necessary, by ITS communications functions. However, it will be a function of the LDM to establish a first level of plausibility of the information carried in a CAM. The LDM should be able to establish that received information is consistent with information received previously from the same source and from other sources near to it. For example, the LDM can determine that there is no unreasonable step change in the time-stamp or location information included in an incoming CAM when compared with recent CAMs from the same ITS station. The same applies to replayed messages. The complexity and variety of the event information carried in DENMs makes it impossible for the LDM to be able determine the plausibility of such messages. This function can only be performed by the ITS applications using DENMs.

An update of LDM object information implies a corresponding update of the associated situational information stored within the LDM. This scenario includes communication between ITS stations using the mechanisms provided by the ITS station access layer. The situational information is provided by:

- CAM messages including status information from nearby vehicle and roadside stations;
- DENM messages describing event information having impact on road safety or traffic efficiency; and
- TPEG messages providing travel and traffic information with potential impact on traffic efficiency.

During the update process of the LDM object information, the incoming messages are:

1) decoded and converted into LDM objects;
2) checked to determine if they imply an update of an existing LDM object or the insertion of a new object into the LDM; and
3) inserted into the LDM or updated.

NOTE: Methods to be used in plausibility checking and the means of reporting and managing suspect (implausible) information should be the subject of future ITS standardization.

6.4.3 LDM - FA-SAP

The LDM - FA-SAP interface enables applications to request access to the LDM and its data. The interface offers functions for applications to manage LDM access, to manage LDM data, to retrieve data and to modify data.

The LDM access management functions allow single applications to:

- retrieve an overview of the services the LDM offers (e.g. what data types are in the LDM); and
- grant access rights to the LDM functionality.

The data management functions allow single applications to:

- set and retrieve data maintenance settings;
- subscribe and unsubscribe to notification functions;
- set notification settings; and
- send notifications to subscribed applications.

The data modification and access functions allow single applications to:

- add, update and delete data;
- read data including the filtering options (see clause 6.3).

The interface handles requests from multiple applications simultaneously. Furthermore it is recommended to enable the prioritization of different applications in order to guarantee that safety critical functions are served even when many non-safety critical applications also request data.

The following is an example workflow for the Road Hazard Warning (RHW) Use Case:

1) The RHW application registers at the LDM subscription/notification component for events which are:
   - of type "warning";
   - within a radius of 200 m referenced to the current position of the host station;
   - not older than 30 seconds.
2) A new RHW message is received by the ITS station.
3) The incoming RHW message is decoded.
4) A basic plausibility check is processed.
5) The LDM management writes the new RHW information into the LDM.
6) The LDM relevance filter checks the relevance of the new event.
7) The LDM Info Access notifies the registered RHW application about the new event and provides all information about the event.

6.4.4 LDM - SF-SAP

The LDM - SF-SAP interface provides access to the ITS station security functions.

In order to avoid potential abuse of LDM data by 3rd-party ITS applications, it will be necessary to implement information access control functions. An application will need to identify itself and be authenticated before it can be authorized to access specific LDM information. The ITS Security Functions (SF) will provide the mechanism required for authentication but it is an LDM function that uses this mechanism to grant or refuse access to information.

NOTE: The methods used by the LDM and the procedures invoked through the LDM-SF SAP in order to provide strong information access control functions as well as the means of reporting and managing authorization failures should be the subject of future ITS standardization.

6.5 LDM and static maps

As there will be ITS stations that have an LDM and a static map, mechanisms for referencing the information that is available in the LDM to the static digital map need to be available. As it is not guaranteed that positioning and map information is accurate, location referencing information is needed for reliably identifying the location of an object in a digital map of the road network. Absolute positioning information is imprecise due to systematic errors in satellite based positioning systems (atmospheric distortions, multipath effects) and other positioning sensors. Different digital maps of the road network are imprecise and show considerable geometry differences with the real-world road network.

The process of encoding a dynamic position of an object in a digital road network and finding this position again in another map is called "dynamic location referencing". Two standardised methods for dynamic location referencing are known:

- OpenLR [i.14] is an industry standard; and
- Agora-C [i.13] is an international standard developed and published by ISO.

Several research projects use position traces for identifying positions in a road network.

A study on location referencing accuracy for ITS systems should be initiated to compare the different methods and identify the location referencing information requirements that has to be supported by the LDM. In any case, it is recommended that received location referencing information are stored within the LDM.

7 Information stored in the LDM

7.1 Introduction

The following clauses present information content that an LDM is to be able to handle. The information is organised in tables that each describe one LDM object. These tables provide a set of minimum requirements that were identified based on a first study of the BSA (clause 5).

NOTE: It is likely that further LDM objects and information elements will be identified and specified during future standardization of the LDM and ITS applications and services.

7.2 Location information

All considered LDM objects contain location information with at least consist of one WGS84 coordinate pair [reference to WGS84].

Three location types are distinguished:

- Point location (e.g. the position of an ITS station).
- Segment location (e.g. the position and extent of a traffic jam).
- Area location (e.g. a weather situation).

For each of these location types, it has to be investigated what location information is required to describe the location, so that applications are able to identify the location with appropriate means.

EXAMPLE: A temporary speed limit information is valid between a start position and an end position. When these positions are further apart, it should be possible for applications to identify the part of the road between the start and end position. This might be realised by explicitly giving information on points on the road between the start and end position.

7.3 Permanent, static information (Type 1)

No permanent, static information is required to be stored in the LDM.

7.4 Transient, static information (Type 2)

No transient, static information is specified in the LDM. Applications may define type 2 information objects that the LDM should be able to store and manage.

7.5 Transient, dynamic information (Type 3)

7.5.1 Temporary speed limit descriptor

The *temporary speed limit* information item in the LDM identifies the location, direction, extent and maximum speed of a designated statutory speed limit. It comprises the elements defined in Table 6.

Table 6: Temporary speed limit information content

Information Element	Type	Status
Location	Location information	
Direction	- From Start to Finish - From Finish to Start - Both	
Speed	Number indicating constrained speed	
NOTE: The value "Both" is assumed if omitted.		

The ITS use cases listed in Table 7 access the *temporary speed limit* information item in the LDM.

Table 7: Use cases accessing the temporary speed limit information element

ITS Use Case	
Identifier	**Title**
UC_RHW_07	Roadwork warning
UC_CSM_01	Regulatory/Contextual speed limit notification

7.5.2 Current status of traffic signals

The *current status of traffic signals* information item indicates the signalling phase facing oncoming traffic at the next set of traffic lights. It comprises the elements described in Table 8.

Table 8: Current status of traffic signals information content

Information Element	Type	Status
Location	Location information	
Intersection identifier	Identification of the intersection under control	
Current signal state	One of the following: - Unknown - Dark - Red - Red-to-green intermediate - Green - Green-to-red intermediate - Flashing amber - Flashing green	
Time until next state change	- Minimum time until change - Maximum time until change	
Next signal status	Choices as for current signal state	

The ITS use cases listed in Table 9 access the *current status of traffic signals* information item in the LDM.

Table 9: Use cases accessing the current status of traffic signals information element

ITS Use Case	
Identifier	**Title**
UC_RHW_06	Signal violation warning
UC_CSM_03	Traffic light optimal speed advisory
UC_CN_03	In-vehicle signage

7.5.3 Location and dimensions of hazard (including stationary vehicle and weather conditions)

The *location of hazard* information item describes where a hazard exists, how big it is and the type of hazard. Its contents are described in Table 10.

Table 10: Location of hazard information content

Information Element	Type	Status
Location	Location information	
Lane identifier	Identity of Lane affected	
Hazard Type	Any combination of: - Congestion - Traffic accident - Road works on road - Narrow lane - Road is not passable - Slippery road - Aquaplaning on road - Burst pipe on road - Fire - Hazardous driving conditions - Obstruction on road - Animals on road - People on road - Broken down vehicles on road - One-way street violation - Rescue and recover work on road - Regulatory measure - Extreme weather conditions - Reduced visibility - Precipitation - Reckless driver - Level crossing failure - Over-height warning activated - Changed traffic regulation - Tunnel ventilation out of order - Major event - Service not operating - Traffic signal malfunction - Service not usable - Slow moving vehicles - Dangerous end of queue - Danger of fire - Giving path for rescue vehicle - Delays on road - Police checkpoint on road	
Traffic status	- traffic flow unknown - free traffic flow - heavy traffic - slow traffic - queuing traffic - stationary traffic - no traffic flow due to closure (by police) - no traffic flow due to blocked road	
Report propagation	- Direction of propagation - Range of propagation	

The ITS use cases listed in Table 11 access the *location of hazard* information item in the LDM.

Table 11: Use cases accessing the location of hazard information element

ITS Use Case	
Identifier	**Title**
UC_RHW_03	Stationary vehicle - Accident
UC_RHW_04	Stationary vehicle - Vehicle problem
UC_RHW_05	Traffic condition warning
UC_RHW_07	Roadwork warning
UC_RHW_08	Decentralized floating car data - Hazardous location
UC_RHW_09	Decentralized floating car data - Precipitation
UC_RHW_10	Decentralized floating car data - Road adhesion
UC_RHW_11	Decentralized floating car data - Visibility
UC_RHW_12	Decentralized floating car data - Wind
UC_CN_01	Traffic information and recommended itinerary

7.5.4 Temporary changes in lane or road direction restrictions

The *temporary lane change* information item describes where lane closures or direction changes exist. Its contents are described in Table 12.

Table 12: Temporary lane change information content

Information Element	Type	Status
Location	Location information	
Lane identifier	Numeric identification of which lane(s) are affected by the restriction	
Restriction Type	One of the following: - Lane closure - Contra-flow	

The ITS use cases listed in Table 13 access the *temporary lane change* information item in the LDM.

Table 13: Use cases accessing the temporary lane change information element

ITS Use Case	
Identifier	**Title**
UC_CA_05	Cooperative merging assistance
UC_CA_06	Intersection collision warning
UC_RHW_02	Wrong-way driving warning (infrastructure based)

7.5.5 Designed progression speed through linked traffic signals

The *designed progression speed* information item specifies the intended speed of progression through a set of linked signal-controlled intersections. Its contents are described in Table 14.

Table 14: Designed progression speed information content

Information Element	Type	Status
Location	Location information	
Progression speed	Speed in km/hr	

The ITS use cases listed in Table 15 access the *designed progression speed* information item in the LDM.

Table 15: Use cases accessing the designed progression speed information element

ITS Use Case	
Identifier	**Title**
UC_CSM_03	Traffic light optimal speed advisory

7.5.6 Revised route descriptor

The *revised route descriptor* information item specifies a possible route to be taken to avoid an existing hazard or obstruction. Its contents are described in Table 16.

Table 16: Revised route descriptor information content

Information Element	Type	Status
Location	Location information	
Route	A sequence of route segment descriptors (see note)	
NOTE: Currently undefined.		

The ITS use cases listed in Table 17 access the *revised route descriptor* information item in the LDM.

Table 17: Use cases accessing the revised route descriptor information element

ITS Use Case	
Identifier	**Title**
UC_CN_01	Traffic information and recommended itinerary

7.5.7 Position of temporary points of interest (including public car parks)

The *temporary point of interest* information item identifies non-permanent points of interest in the area local to the host vehicle. Its contents are described in Table 18.

Table 18: Temporary point of interest information content

Information Element	Type	Status
POI name	Text string	
POI location	Location information	
POI type	(Note)	
Parking facilities	- Park & ride/park & walk - Total number of spaces - Available free spaces	
NOTE: Currently undefined but could include: - sporting event; - entertainment festival; - temporary public parking.		

The ITS use cases listed in Table 19 access the *temporary point of interest* information item in the LDM.

Table 19: Use cases accessing the temporary point of interest information element

ITS Use Case	
Identifier	**Title**
UC_LBS_01	Point of interest notification
UC_LBS_02	Automatic access control and parking management

7.5.8 Position and meaning of temporary signs not in the pre-loaded map data

The *temporary road sign* information item defines the position and meaning of any temporary road signs that are not known to the navigation and mapping system. Its contents are described in Table 20.

Table 20: Temporary road sign descriptor information content

Information Element	Type	Status
Location of temporary sign	Location information	
Type of sign	Type code specified in UNECE Vienna convention on Traffic Signs and Signals [i.5]	
Value on traffic sign	Additional parameter characterizing the temporary sign	

The ITS use cases listed in Table 21 access the *temporary point of interest* information item in the LDM.

Table 21: Use cases accessing the temporary point of interest information element

ITS Use Case	
Identifier	**Title**
UC_LBS_01	Point of interest notification
UC_LBS_02	Automatic access control and parking management

7.6 Highly dynamic information (Type 4)

7.6.1 Current status of all ITS Stations within range of the host

The *current status of in-range ITS stations* information item in the LDM maintains the identification, position, speed and other dynamic information received from all vehicles within ITS G5 range of the host station. It comprises the elements defined in Table 22.

Table 22: Nearby vehicle descriptor information content

Information Element	Type	Status
Vehicle identifier	Pseudonymous identity	
Vehicle position	- Latitude - Longitude - Position confidence (%) - Elevation - Elevation confidence (%) - Heading - Heading confidence (%)	
Vehicle type	One of the following: - car - lorry - bus - taxi - train - motor cycle - vehicle with trailer - motor vehicles - transport of dangerous goods - transport of abnormal load - heavy vehicle - … (e.g. military vehicle)	(see note 1) (see note 2)
Acting as emergency vehicle	Yes / No	
	Any combination of: - Light bar in use - Siren in use	Optional
	Emergency vehicle indication	

Information Element	Type	Status
Vehicle dimensions	Emergency response type	
Vehicle speed	- Current speed - Speed confidence factor (%) - Acceleration - Acceleration confidence (%)	
Yaw	- Yaw rate - Yaw rate confidence (%)	
Acceleration control	Any combination of: - Brake pedal - Accelerator pedal - Cruise control - ACC - Speed limiter - Brake assistance	
Ambient air temperature		
Traffic-affecting hazard cause	Any combination of: - traffic congestion - accident - roadworks - narrow lanes - impassibility - slippery road - aquaplaning - fire - hazardous driving conditions - objects on the road - animals on roadway - people on roadway - broken down vehicles - vehicle on wrong carriageway (Ghostdriver) - rescue and recovery work in progress - regulatory measure - extreme weather conditions - visibility reduced - precipitation - reckless persons - overheight warning system triggered - traffic regulations changed - major event - service not operating - service not useable - slow moving vehicles - dangerous end of queue - risk of fire - time delay - police checkpoint - malfunctioning roadside equipment - test message	(see note 2) (see note 3)
External lights on	Any combination of: - Low beam headlights - High beam headlights - Left turn signal - Right turn signal - Automatic light control - Daytime running lights - Fog light - Parking lights	
Route navigation advice	- Direction of next routed turn - Distance to next routed turn - Distance to next stop line	
Vehicle occupancy (%)	-	
Traffic signal priority	Priority treatment to be given to vehicle at traffic signals	

Information Element	Type	Status
Door open indicator	Any combination of: - Drivers door - Any passenger door - Maintenance access door - Luggage compartment door	
Current road curvature	- Determined curvature - Change of curvature - Confidence in curvature (%)	
Front wiper setting	One of the following states: - Idle - Intermittent - Normal - Fast - Washer active	
Crash status	One of the following states - Vehicle crashed - Vehicle progressing normally	
Dangerous cargo	UNECE classification code for the dangerous goods [i.4] carried by the vehicle	
NOTE 1: Vehicle types taken from TPEG-TEC version 3.0, table "tec009 Vehicle Type" [i.7]. NOTE 2: This is a minimal list and can be extended. NOTE 3: Cause codes taken from TPEG-TEC version 3.0, table "tec002 Cause Code" [i.7].		

The *current status of in-range ITS stations* information item in the LDM maintains the identification, position and other dynamic information received from all roadside units within ITS G5 range of the host station. It comprises the elements defined in Table 23.

Nearby infrastructure descriptor information content.

Table 23: Nearby roadside descriptor information content

Information Element	Type	Status
Roadside identifier	Pseudonymous identity	
Roadside position	Location information	
Roadside type	One of the following: - … (e.g. traffic light)	(see note 1)
Traffic-affecting hazard cause	Any combination of: - traffic congestion - accident - roadworks - narrow lanes - impassibility - slippery road - aquaplaning - fire - hazardous driving conditions - objects on the road - animals on roadway - people on roadway - broken down vehicles - vehicle on wrong carriageway (Ghostdriver) - rescue and recovery work in progress - regulatory measure - extreme weather conditions - visibility reduced - precipitation - reckless persons - overheight warning system triggered - traffic regulations changed - major event - service not operating - service not useable - slow moving vehicles - dangerous end of queue - risk of fire - time delay - police checkpoint - malfunctioning roadside equipment - test message	(see note 2) (see note 3)
NOTE 1: Currently undefined. NOTE 2: This is a minimal list and can be extended. NOTE 3: Cause codes taken from TPEG-TEC version 3.0, table "tec002 Cause Code" [i.7].		

The ITS use cases listed in Table 24 access the *current status of in-range ITS stations* information item in the LDM.

Table 24: Use cases accessing the current status of in-range ITS stations information element

ITS Use Case	
Identifier	**Title**
UC_CA_01	Emergency vehicle warning
UC_CA_02	Slow vehicle indication
UC_CA_03	Across traffic turn collision risk warning
UC_CA_04	Merging traffic turn collision risk warning
UC_CA_05	Cooperative merging assistance
UC_CA_06	Intersection collision warning
UC_CA_07	Cooperative forward collision warning
UC_CA_08	Lane change manoeuvre
UC_RHW_01	Emergency electronic brake lights
UC_RHW_02	Wrong way driving (infrastructure based)
UC_RHW_03	Stationary vehicle - accident
UC_RHW_04	Stationary vehicle - vehicle problem
UC_RHW_05	Traffic condition warning
UC_RHW_13	Vulnerable road user warning
UC_RHW_14	Pre-crash sensing warning
UC_RHW_15	Cooperative glare reduction
UC_LCM_02	Vehicle and RSU data calibration

8 Recommendations for future LDM standardization

- R1-LDM-ETSI: It is recommended to standardize at least the LDM objects types and information elements identified in clause 7 of the present document in order to comply with the BSA requirements.
- R2-API-ETSI: It is recommended to standardize the behavior of interfaces as identified in clause 6.
- R3-Location info-ISO: It is recommended that all LDM objects contain at minimum location information with at least one WGS84 coordinate pair.
- R4-Location info-ISO: For each of the location information types (i.e. point location, linear location and area location) it is recommended to investigate what location information is required to describe the location.
- R5-Location referencing: It is recommended to initiate a study on location referencing accuracy for ITS systems. Goal of the study should be to clarify location referencing precision requirements and to identify suitable location referencing methods for scenarios of LDMs without static maps and LDMs with static maps. If no suitable location referencing method is found, it is recommended to develop and standardize such a method.
- R6-SEC-ETSI: It is recommended that the methods to be used in checking the plausibility of CAMs and the means of reporting and managing suspect (implausible) information should be the subject of future ITS standardization.
- R7-SEC-ETSI: It is recommended that the methods used by the LDM and the procedures invoked through the LDM-SF SAP in order to provide strong information access control functions as well as the means of reporting and managing authorization failures should be the subject of future ITS standardization.
- R8-ETSI and TISA: Further investigation is recommended on CAM, DENM and TPEG messages to include missing information types and location referencing information as identified in recommended studies in R4, R5 and R6.
- R9-ETSI and TISA: It is recommended to ensure that the CAM, DENM and TPEG messages provide the information identified during further standardization of the LDM.

- R10-ETSI: It is recommended that consideration should be given to the reliability of an ITS station in general (and the LDM in particular) as a potential regulatory requirement supported by European standardization.
- R11-ETSI: It is recommended that further study should be undertaken into the methods and message formats required for the interchange and storage of local, detailed and accurate digital map segments for use by applications which would benefit by the availability of such information within the LDM.

Annex A:
Detailed analysis of the ETSI BSA

A.1 Use case analysis

An analysis of a wide range of ITS use cases revealed what information should be maintained in an LDM. These use cases are taken from the ITS Basic Set of Applications [i.3], the EC funded projects SAFESPOT [i.9], CVIS [i.8] and COOPERS [i.12] and the Car-to-Car Consortium Manifesto [i.11]. Table A-1 lists each of the use cases considered in the analysis, assigning a unique identifier, providing a brief description and identifying the source(s).

Table A-2 summarizes the results of the analysis by listing the information which each use case requires to be maintained in the ITS LDM in order to function correctly. These information items are classified into the 4 different types of data specified in clause 4.1.

Table A-1: Summary of ITS use cases in LDM analysis

Applications Class	Application	Use Case Number	Use case	Use case short description	Source	Other sources
Active road safety	Driving assistance - Co-operative Awareness (CA)	UC_CA_01	Emergency vehicle warning	Allows an active emergency vehicle to indicate its presence.	TS 102 637-1 [i.15] (UC001)	TR 102 762 [i.10] EC SAFESPOT project
		UC_CA_02	Slow vehicle indication	Allows a slow vehicle to signal its presence (vehicle type) to other vehicles.	TS 102 637-1 [i.15] (UC002)	EC SAFESPOT project
		UC_CA_03	Across traffic turn collision risk warning	Informs approaching vehicles that a vehicle (the transmitting vehicle) is intending to turn across traffic.	TS 102 637-1 [i.15] (UC012)	
		UC_CA_04	Merging Traffic Turn Collision Risk Warning	Provides information of presence, position and movement of incoming vehicles from connecting roads that merge on the current road and cross the current lane.	TS 102 637-1 [i.15] (UC012)	EC CVIS project
		UC_CA_05	Co-operative merging assistance	Considers that the vehicles involved in a merging negotiate together the merging process to avoid collision. If the concerned vehicles have map data bases, the merging region can be determined in co-operation.	TR 102 638 [i.3]	EC CVIS project
		UC_CA_06	Intersection collision warning	Allows that where there is a risk of collision at an intersection, vehicles in the affected area are informed in order to mitigate the risk.	TS 102 637-1 [i.15] (UC003)	TR 102 762 [i.10] EC SAFESPOT project C2C consortium manifesto EC CVIS project
		UC_CA_07	Co-operative forward collision warning	Detects a risk of forward collision to avoid accidents either through driver assistance or direct action on the car	TR 102 638 [i.3]	EC CVIS project
		UC_CA_08	Lane Change Manoeuvre	Informs a driver about vehicles in its blind spot region.	EC SAFESPOT project	
	Driving assistance - Road Hazard Warning (RHW)	UC_RHW_01	Emergency electronic brake lights	Allows a vehicle to signal its hard breaking to its local followers.	TS 102 637-1 [i.15] (UC005)	TR 102 762 [i.10] C2C consortium manifesto
		UC_RHW_02	Wrong way driving warning (infrastructure based)	The infrastructure detects the wrong way driver and sends wrong-way driver warning messages to vehicles in the vicinity.	TS 102 637-1 [i.15] (UC006)	EC SAFESPOT project EC COOPERS project
		UC_RHW_03	Stationary vehicle - accident	Allows a vehicle immobilized due to an accident to signal its presence to other approaching vehicles.	TS 102 637-1 [i.15] (UC007)	TR 102 762 [i.10] EC SAFESPOT project EC COOPERS project
		UC_RHW_04	Stationary vehicle - vehicle problem	Allows a vehicle immobilized due to a serviceability problem to signal its presence to other approaching vehicles.	TS 102 637-1 [i.15] (UC008)	TR 102 762 [i.10] EC SAFESPOT project
		UC_RHW_05	Traffic condition warning	Allows any vehicle or roadside station to signal to other vehicles or infrastructure the current traffic condition at the point of sensor.	TS 102 637-1 [i.15] (UC009)	TR 102 762 [i.10] EC SAFESPOT project EC COOPERS project

Applications Class	Application	Use Case Number	Use case	Use case short description	Source	Other sources
		UC_RHW_06	Signal violation warning	Allows a detecting ITS station (most likely a road side unit) to signal to affected users that a vehicle has violated a road signal and increased the risk of an accident.	TS 102 637-1 [i.15] (UC010)	EC SAFESPOT project
		UC_RHW_07	Roadwork warning	Provides information on current valid roadwork and associated constraints.	TS 102 637-1 [i.15] (UC011)	EC SAFESPOT project EC COOPERS project
		UC_RHW_08	Decentralized floating car data - Hazardous location	Allows a vehicle to detect and signal to other vehicles a local danger or traffic flow problem. Such information can be propagated to a certain distance (e.g. 20 km) through other ITS stations using geocasting capabilities.	TS 102 637-1 [i.15] (UC013)	EC SAFESPOT project TR 102 762 [i.10] C2C consortium manifesto EC CVIS project
		UC_RHW_09	Decentralized floating car data - Precipitations	See UC_RHW_08	TS 102 637-1 [i.15] (UC014)	TR 102 762 [i.10] EC COOPERS project
		UC_RHW_10	Decentralized floating car data - Road adhesion	See UC_RHW_08	TS 102 637-1 [i.15] (UC015)	TR 102 762 [i.10] EC SAFESPOT project EC COOPERS project
		UC_RHW_11	Decentralized floating car data - Visibility	See UC_RHW_08	TS 102 637-1 [i.15] (UC016)	EC SAFESPOT project EC COOPERS project
		UC_RHW_12	Decentralized floating car data - Wind	See UC_RHW_08	TS 102 637-1 [i.15] (UC017)	TR 102 762 [i.10] EC COOPERS project
		UC_RHW_13	Vulnerable road user Warning	Provides warning to vehicles of the presence of vulnerable road users, e.g. pedestrian or cyclist, in case of a dangerous situation.	TR 102 638 [i.3]	EC SAFESPOT project
		UC_RHW_14	Pre-crash sensing warning	Prepares for imminent and unavoidable collision by exchanging vehicles attributes after an impending and unavoidable crash is detected.	TR 102 638 [i.3]	
		UC_RHW_15	Co-operative glare reduction	Enables a capable vehicle to automatically switch from main beam to dipped headlights when detecting a vehicle approaching in the opposite direction.	TR 102 638 [i.3]	

Applications Class	Application	Use Case Number	Use case	Use case short description	Source	Other sources
Cooperative traffic efficiency	Co-operative Speed Management (CSM)	UC_CSM_01	Regulatory / contextual speed limits notification	Informs vehicles of any permanent and temporary speed limits currently in force.	TS 102 637-1 [i.15] (UC018)	EC SAFESPOT project EC COOPERS project EC CVIS project
		UC_CSM_02	Curve Warning	Provides information on curves ahead. Information includes advised speed based on properties of the curve and on other vehicles in the curve.	EC SAFESPOT project	
		UC_CSM_03	Traffic light optimal speed advisory	Allows a traffic light to broadcast timing data associated to its current state (e.g. time remaining before switching between green, amber, red). It is useful in order to regulate traffic at an intersection.	TS 102 637-1 [i.15] (UC019)	C2V consortium manifesto
	Co-operative Navigation (CN)	UC_CN_01	Traffic information and recommended itinerary	Provides assistance to travellers and drivers comprising: a)pre-trip and on-trip Planning; b) on-trip seamless service with tracking and rerouting if needed; c) vehicle data feed to traffic control centres	TS 102 637-1 [i.15] (UC020)	TR 102 762 [i.10] EC SAFESPOT project EC COOPERS project EC CVIS project C2C consortium manifesto
		UC_CN_02	Public transport information	Provides access to local public transport information to improve / influence routing recommendations	EC CVIS project	
		UC_CN_03	In-vehicle signage	Provides vehicles with information on current valid traffic signs	TS 102 637-1 [i.15] (UC023)	EC CVIS project
Co-operative local services	Location Based Services (LBS)	UC_LBS_01	Point of Interest notification	Provides information about the presence of locally based services or/and Points of Interest. This UC can provide some dynamic information such as the opening hours, prices, waiting time, available room, promotions etc.	TS 102 637-1 [i.15] (UC024)	TR 102 762 [i.10] C2C consortium manifesto
		UC_LBS_02	Automatic access control and parking management	Facilitates authorized vehicle access to controlled areas: (e.g. a private or public parking)	TS 102 637-1 [i.15] (UC025)	TR 102 762 [i.10] C2C consortium manifesto EC CVIS project
		UC_LBS_03	ITS local electronic commerce	Provides information on the capabilities of Points of Interest and locally based services to process a local electronic payment for service reservation or/and some good purchasing.	TS 102 637-1 [i.15] (UC026)	TR 102 762 [i.10] EC CVIS project
		UC_LBS_04	Media downloading	Allows the access, purchase and, downloading of multimedia content for passenger entertainment from a local RSU which may offer Internet access to a dedicated WEB site.	TS 102 637-1 [i.15] (UC027)	C2V consortium manifesto

Applications Class	Application	Use Case Number	Use case	Use case short description	Source	Other sources
Global internet services	Communities services (CS)	UC_CS_01	Insurance and financial services	Allows the delivery of Insurance and financial services to the customer.	TS 102 637-1 [i.15] (UC028)	TR 102 762 [i.10]
		UC_CS_02	Fleet management	Improves mobility and economical efficiency of a professional fleet of vehicles.	TS 102 637-1 [i.15] (UC029)	TR 102 762 [i.10]
		UC_CS_03	Loading zone management	Supports the driver, fleet manager and road operator (including parking zone operator) in the booking, monitoring and management of the urban parking zones for freight driver activities.	TS 102 637-1 [i.15] (UC030)	TR 102 762 [i.10]
		UC_CS_04	Theft related services/After theft vehicle recovery	Enables a vehicle to communicate that it is in "stolen status" (this status is automatically triggered by the vehicle or remotely by an operator).	TR 102 762 [i.10]	
	ITS station Life Cycle Management (LCM)	UC_LCM_01	Vehicle software / data provisioning and update	Allows the provision and update of ITS software and data using V2I and V2V communications for improved service quality, improved maintenance management for vehicles.	TS 102 637-1 [i.15] (UC031)	TR 102 762 [i.10] EC COOPERS project C2C consortium manifesto
		UC_LCM_02	Vehicle and RSU data calibration.	Allows online sensor calibration using V2I and V2V communications for improved service quality, improved maintenance management for vehicles and RSUs.	TS 102 637-1 [i.15] (UC032)	
	Transport related electronic financial transactions (road tolls)			Facilitates automatic payment when passing toll collection points in all European Countries.	EC SAFESPOT project	

Table A-2: Information elements required by each use case

Use Case Number	Use case	Type 1 Data	Type 2 Data	Type 3 Data	Type 4 Data
UC_CA_01	Emergency vehicle warning				Current speed, position and direction of emergency vehicle
UC_CA_02	Slow vehicle indication				Current speed, position and direction of emergency vehicle
UC_CA_03	Across traffic turn collision risk warning				Current speed, position and direction of turning vehicle
UC_CA_04	Merging Traffic Turn Collision Risk Warning				Current speed, position and direction of turning vehicle
UC_CA_05	Co-operative merging assistance	Lane precise local road topography		Temporary changes in lane or road direction restrictions (e.g. Contra-flow system through motorway road works)	Current speed, position and direction of all other nearby vehicles
					Distinguishing identifiers of each vehicle
UC_CA_06	Intersection collision warning	Lane precise local road topography		Temporary changes in lane or road direction restrictions (e.g. Contra-flow system through motorway road works)	Current speed, position and direction of all other nearby vehicles
					Distinguishing identifiers of each vehicle
UC_CA_07	Co-operative forward collision warning				Current speed, position and direction of all other nearby vehicles
					Distinguishing identifiers of each vehicle
UC_CA_08	Lane Change Manoeuvre	Lane precise local road topography			Current speed, position and direction of all other nearby vehicles
					Distinguishing identifiers of each vehicle
UC_RHW_01	Emergency electronic brake lights				Current speed, position and direction of all other nearby vehicles

Use Case Number	Use case	Type 1 Data	Type 2 Data	Type 3 Data	Type 4 Data
UC_RHW_02	Wrong way driving warning (infrastructure based)	Lane precise local road topography		Temporary changes in lane or road direction restrictions (e.g. Contra-flow system through motorway road works)	
UC_RHW_03	Stationary vehicle - accident			Position, type and status of stationary vehicle	
UC_RHW_04	Stationary vehicle - vehicle problem			Position, type and status of stationary vehicle	
UC_RHW_05	Traffic condition warning			Traffic situation	Current speed, position and direction of other vehicles within range of the host.
UC_RHW_06	Signal violation warning	Lane precise local road topography		Current status of traffic signals.	
UC_RHW_07	Roadwork warning	Local road topography		Location and dimensions of road works Temporary speed restrictions	
UC_RHW_08	Decentralized floating car data - Hazardous location			Location and dimensions of hazard	
UC_RHW_09	Decentralized floating car data - Precipitations				
UC_RHW_10	Decentralized floating car data - Road adhesion				
UC_RHW_11	Decentralized floating car data - Visibility				
UC_RHW_12	Decentralized floating car data - Wind				
UC_RHW_13	Vulnerable road user Warning	Local road topography			Current speed, position and direction of vulnerable vehicle
UC_RHW_14	Pre-crash sensing warning				Current speed, position and direction of all other nearby vehicles
UC_RHW_15	Co-operative glare reduction				Current speed, position and direction of all other nearby vehicles
UC_CSM_01	Regulatory/contextual speed limits notification			Temporary speed limit descriptor	
UC_CSM_02	Curve Warning				
UC_CSM_03	Traffic light optimal speed advisory			Current status and time to next phase of traffic signals	

Use Case Number	Use case	Type 1 Data	Type 2 Data	Type 3 Data	Type 4 Data
UC_CN_01	Traffic information and recommended itinerary	Local road topography Pre-planned route descriptors		Revised route descriptor	
UC_CN_02	Public transport information				
UC_CN_03	In-vehicle signage		Position and meaning of new and temporary signs not in the pre-loaded map data.	Current status of traffic signs.	
UC_LBS_01	Point of Interest notification	Local road topography Position of permanent local points of interest	Position of new or temporary points of interest		
UC_LBS_02	Automatic access control and parking management				
UC_LBS_03	ITS local electronic commerce				
UC_LBS_04	Media downloading				
UC_CS_01	Insurance and financial services				
UC_CS_02	Fleet management				
UC_CS_03	Loading zone management				
UC_CS_04	Theft related services/After theft vehicle recovery				
UC_LCM_01	Vehicle software/data provisioning and update				
UC_LCM_02	Vehicle and RSU data calibration.				Current speed, position and direction of other vehicles

Annex B: Bibliography

TPEG TFP: "TISA Specification SP10011 - Traffic and Travel Information (TTI) - TTI via Transport Protocol Expert Group, Generation 2 (TPEG2) - Part 18: Traffic Flow and Prediction application".

ETSI TR 102 893: "Intelligent Transport Systems (ITS); Security; Threat, Vulnerability and Risk Analysis (TVRA)".

History

Document history		
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