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Intelligent transport systems — Cooperative systems — State of the art of Local Dynamic Maps concepts

Systèmes intelligents de transport — Systèmes coopératifs — État des connaissances des cartes dynamiques locales

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 204, *Intelligent transport systems*.

Introduction

Intelligent transport systems (ITS) means to apply information and communication technologies (ICT) to the transport sector. ITS can create clear benefits in terms of transport efficiency, sustainability, safety and security.

To take full advantage of the benefits that ICT-based systems and applications can bring to the transport sector, it is necessary to ensure interoperability among the different systems.

Cooperative systems are ITS (Cooperative ITS) systems based on vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I, I2V) and infrastructure-to-infrastructure (I2I) communications for the exchange of information. Cooperative systems have the potential to further increase the benefits of ITS services and applications.

Cooperative ITS is a subset of the overall ITS that communicates and shares information between ITS stations to give advice or facilitate actions with the objective of improving safety, sustainability, efficiency and comfort beyond the scope of stand-alone systems.

The European Commission issued Mandate M/453 [6] [7] to invite the European Standardization Organizations (ESOs) (CEN, CENELEC and ETSI) to prepare a coherent set of standards, specifications and guidelines to support the European Community's wide implementation and deployment of Cooperative intelligent transport systems (Cooperative ITS).

CEN and ETSI have formally accepted the Mandate and will develop standards (EN) and technical specifications and guidelines requested as far as possible within the timescale required in the Mandate. (see Reference [7])

Annex C of Reference [7] proposes a "List of minimum set of standards and allocation of responsibility between CEN and ETSI – Mandate M/453".

ISO/TC 204 decided in 2009 to join CEN's efforts and to create a new working group (WG 18) under the Vienna agreement. This Technical Report is considered by non-European NSOs as important enough to justify having it under ISO lead.

Different ITS stations (vehicle, nomadic, roadside and central) exchange geographically located information, which is of importance for the different cooperative applications (standards to be developed under the responsibility of CEN and ISO).

This Technical Report delivers information about the status at the time of publication of the Local Dynamic Map (LDM) concepts as they have been developed in the different R&D projects in Europe, Japan and the USA.

It presents different architectures, implementations, LDM functional blocks and the related standardization activities. It can identify gaps, lacks and inconsistencies between Cooperative ITS Reference Station Architecture and existing implementations. It proposes actions for future standardization activities and harmonization needs. Activities within ISO/TC 204 WG 3 and ETSI TC ITS at the time of publication are considered.

This Technical Report falls within the agreed scope of work of ISO/TC 204 WG18 and CEN TC 278 WG16.

Intelligent transport systems — Cooperative systems — State of the art of Local Dynamic Maps concepts

1 Scope

This Technical Report surveys the status of Local Dynamic Map (LDM) regarding architecture, implementation, and standardization efforts. It summarizes the high level architectures of the most important implementations and compares it with the CEN/ETSI/ISO ITS-Station architecture.

This Technical Report derives out of the application needs the requirements for a global LDM concept in terms of functionality, technical and legal aspects.

A gap analysis with existing specification and standards will be performed and recommendations towards SDOs and decision bodies will be made.

This Technical Report does not give any decision on how or whether one of the solutions described is commercially feasible to be considered as an implementable offer to the user.

This Technical Report considers the most important documents and research projects to the knowledge of the authors, but does not claim to be complete or free of any mistakes.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable to its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/TR 24532, *Intelligent transport systems — Systems architecture, taxonomy and terminology — Using CORBA (Common Object Request Broker Architecture) in ITS standards, data registries and data dictionaries*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/TR 24532 and the following apply.

3.1
Local Dynamic Map
LDM
conceptual data store which is embedded in an ITS station containing topographical, positional and status information within a dedicated geographic area of interest, relevant to ITS stations

Note 1 to entry: The LDM is supported by service functions, which ensure the accessibility, integrity, and security.

4 Abbreviated terms

For the purposes of this document, the following abbreviated terms apply.

API	Application Program Interface
BSA	Basic Set of Applications
CA	Cooperative Awareness
CAM	Cooperative Awareness Message

CN	Cooperative Navigation
COOPERS	COOPERative systems for intelligent road Safety
CS	Communities Service
CSM	Cooperative Speed Management
CVIS	Cooperative Vehicle-Infrastructure Systems
DENM	Decentralized Environmental Notification Message
FA	Facilities/Applications
ICT	Information and Communication Technology
ITS	Intelligent Transport System
IRIS	Intelligent Cooperative Intersection Safety system
LBS	Location-Based Service
LCM	Life Cycle Management
LDM	Local Dynamic Map
MF	Management/Facilities
NF	Networking and 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

5 Content and structure

How a LDM is built, which elements are needed and how they are implemented, strongly depends on the role of an ITS station.

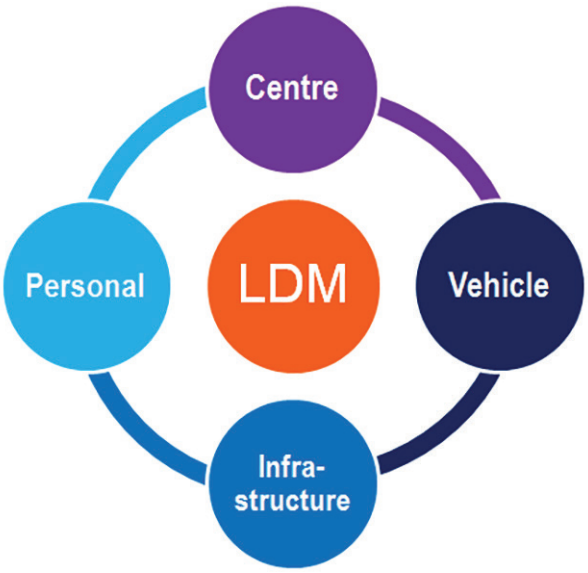

Figure 1 — Viewpoints in respect of the LDM

5.1 Required LDM Elements (subsystems or functions)

A typical LDM consists of following subsystems:

— LDM management, including

  — means for synchronizing content in-between LDMs,

  — means for updating content, and

  — means for removing outdated data elements;

— LDM Data Storage

  — data storage, which covers small to huge implementations supporting personnel devices, infrastructure systems, in-vehicle platforms, service providers and management centres;

— LDM Security

  — means for data security;

— LDM Content Integrity

  — means for maintaining data integrity and quality, and

  - decision rules on conflicting data;
- LDM Privacy Policy Advisor
  - rules on how to deal with privacy-affected static, quasi-static and dynamic content;
- LDM Arbiter/Screening, prioritizing
  - means for putting multiple queries according their priority to the data storage and retrieving the response;
- LDM SAPs/Data access
  - interface for writing elements into and retrieving elements from the data storage;
- LDM Broker
  - shared data management for multiple application access.

All the data elements and their attributes put in and out the LDM have to comply with the definition given in the LDM Data dictionary.

5.1.1 Data elements and protocols

The input to the LDM may come from many sources likely using different protocols. Messages originating from vehicles, for instance CAM and DENM, use a highly condensed protocol format to keep channel blocking at a minimum. There is only a minimum of additional information contained in the message itself to decide on reliability and confidence. Other input sources are radio broadcasts (RDS, DAB, DVB, DMB) using, e.g. TMC or TPEG protocol, traffic centre using DATEX/DATEX2 or HTML-based application data exchange format and so on. If data from different sources addressing the same event have a contradicting meaning, the following additional decision-relevant information has to be considered to get the most accurate information:

- Who is the issuer of the information?
- How and when was the information generated?
- What is the accuracy of the information?
- How was the information transmitted?
- Where and under which condition is the information valid?

5.1.1.1 TPEG in detail

Detailed information on TPEG is provided in [21].

TPEG (Transport Protocol Experts Group) specifications[9] offer a method for transmitting multimodal traffic and travel information, regardless of client type, location or required delivery channel (e.g. DAB, HD radio, Internet, DVB-x, DMB, GPRS, Wi-Fi …). Language independence has also been a prime principle in the design.

5.1.1.1.1 How does TPEG work?

In contrast to TMC (event-based road traffic information), TPEG refers to a whole set or toolkit of specifications, for offering a wider range of services to a wider range of users and devices.

TPEG services are defined in a modular way and can therefore vary in a number of “directions”:

- application, e.g. Road Traffic Messages, Public Transport Information or Parking Information. Each Application is uniquely identified by an Application ID (AID) that are allocated by the TPEG Application Working Group (TAWG) of TISA;

— transmission method, e.g. DAB digital radio, DMB, Internet;

— location referencing method, e.g. table-based (using for example TMC location tables) or on-the-fly (using a method that gives a location reference that works with or without maps and does not require a look-up table to decode in the receiver);

— device, e.g. intended for vehicle navigation systems, Internet browsers or mobile devices;

— conditional access: whether data are sent for free or only to users/devices who have somehow established the right to receive it, e.g. by paying a subscription. Encryption of TPEG data are possible by means of Standardised Encryption Indicators, which are allocated by the TPEG Application Working Group (TAWG) of TISA.

The term "profile" is used to define a combination of the above which, together, make up what one might think of as a single TPEG service. For example:

— displaying traffic incidents on a map graphic and supporting re-routing or route optimization;

— displaying public transport status information on a cell phone screen.

5.1.1.1.2 TPEG Service IDs

Any TPEG-service is uniquely identified worldwide by a TPEG Service ID (SID) consisting of three elements called SID-A, SID-B, SID-C, as described in ISO/TS 18234-2. TISA, as worldwide registrar for TPEG SID, is responsible for allocating and maintaining TPEG Service IDs in a Registry to ensure a worldwide unique identification of a TPEG service.

Each TPEG Application is assigned a unique number called the Application Identifier (AID) which is standardized in ISO/TS 18234-1. An AID is defined whenever a new application is developed. The AIDs allocated at the time of publication of this Technical Report are the following (see Table 1):

Table 1 — TPEG AID table

AID Number (Hex)	Application	Abbreviated term
0	Service and Network Information application	SNI
1	Road Traffic Message application	RTM
2	Public Transport Information application	PTI
3	Parking Information application	PKI
4	Congestion and Travel Time application	CTT
5	Traffic Event Compacy application	TEC
6	Conditional Access Information application	CAI
7	Traffic Flow and Prediction	TFP
8	Fuel Price Information	FPI

5.1.1.2 DATEX/DATEX2

Detailed Information on DATEX/DATEX2 are provided in[22].

5.1.1.2.1 Background

Delivering European Transport Policy in line with the ITS Action Plan of the European Commission requires coordination of traffic management and development of seamless pan-European services. With the aim to support sustainable mobility in Europe, the European Commission has been supporting the development of information exchange mainly between the actors of the road traffic management domain for a number of years. In the road sector, the DATEX standard was developed for information exchange between traffic management centres, traffic information centres and service providers and constitutes

the reference for applications that have been developed in the past 10 years. At the time of publication of this Technical Report, the second generation DATEX II specification also pushes the door wide open for all actors in the traffic and travel information sector.

Much investment has been made in Europe, both in traffic control and information centres over the last decade and also in a quantum shift in the monitoring of the trans-European transport network (TEN-T). This is in line with delivering the objectives of the EasyWay programme [17] for safer roads, reduced congestion and a better environment. Collecting information is only part of the story; to make the most of the investment data needs to be exchanged both with other centres and, in a more recent development, with those developing pan-European services provided directly to road users. DATEX was originally designed and developed as a traffic and travel data exchange mechanism by a European task force set up to standardize the interface between traffic control and information centres. With the new generation DATEX II, it has become the reference for all applications requiring access to dynamic traffic and travel-related information in Europe.

5.1.1.2.2 Organization: SG - TG - User Forum

The DATEX II specifications are maintained at the time of publication by a stakeholder organization that has been created under the EasyWay programme. In EasyWay, DATEX II is included in a set of European Studies (ES) that deal with pan-European consensus forming and harmonization. DATEX II is covered by European Study 5, chaired by Germany at the time of publication.

ES5 has been structured into two working groups:

— The Strategic Group (SG) steers the work programme of ES5 and reports to the EasyWay Steering Committee and the European Commission. SG itself takes care of liaison with other relevant stakeholder groups and outreach activities, for instance the organization of a DATEX II User Forum. Technical day-to-day work is assigned by the SG to a dedicated technical working group.

— The Technical Group (TG) receives its terms of reference from the SG, and also reports back on its progress. The TG consists of technical experts that deal with the day-to-day management of the DATEX II specifications, which includes user support and user feedback via this website, but also all technical work required in preparation of the DATEX II standardization. TG therefore works in close cooperation with CEN/TC 278/WG 8.

The organizational structure presented is seen as a temporary solution during the life of the EasyWay programme. In parallel to the work programme described above, the SG and the TG work together on defining a long term, self-sustained organizational structure for the time after EasyWay.

5.1.1.2.3 Standardization

DATEX II is intended to become a multi-part standard, maintained by CEN/TC 278 (see www.itsstandards.eu). The first three parts of the CEN DATEX II series [i.e. CEN/TS 16157 (all parts)] deal with the most mature and widely used parts of DATEX II: the modelling methodology (called Context and framework) as CEN/TS 16157-1, Location referencing as CEN/TS 16157-2 and the most widely used DATEX publication for traffic information messages (called Situation publication) as CEN/TS 16157-3.

A fourth part of the CEN DATEX II series, VMS publications, is being proposed for standardization to CEN/TC 278. More parts are to follow, including other data publications for example measured data and elaborated data.

5.2 LDM: state of the art

5.2.1 Proposed LDM Architectures

5.2.1.1 SAFESPOT

See also Specification[12].

