TECHNICAL SPECIFICATION

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# Intelligent transport systems — Cooperative systems — Definition of a global concept for Local Dynamic Maps

*Systèmes intelligents de transport — Systèmes coopératifs — Définition d'un concept global pour cartes dynamiques locales*

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# Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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.

ISO/TS 18750 was prepared by the European Committee for Standardization (CEN) in collaboration with ISO/TC 204, *Intelligent transport systems*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

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# Introduction

An essential property of cooperative intelligent transport systems (C-ITS)[16] is the sharing of data between different ITS applications providing different ITS services to the users. This approach replaces the traditional approach where each application is operated in an isolated environment, i.e. referred to as “silo approach”. The C-ITS approach enables synergies in components of an ITS station unit, e.g. sharing of communication tools, improves overall performance and reliability, and reduces overall cost. In order to protect the interests of the various ITS applications, C-ITS implements the concept of an ITS station (ITS-S) operated as bounded secured managed domain.

The sharing of data between applications is achieved by subscribe/publish mechanisms, where at least two mechanisms are distinguished, i.e. one allowing ITS-S application processes to subscribe to standardized messages from ITS message sets (direct forwarding upon reception of such messages in an ITS station unit) and one using a Local Dynamic Map (LDM) as repository of standardized data objects. Such data objects stored in an LDM are named LDM Data Objects (LDM-DOs). LDM-DOs provide self-consistent information on real objects existing at a given geo-location during a given lifetime-interval. Authorized ITS-S application processes may add LDM-DOs to an LDM and may retrieve LDM-DOs from an LDM. Retrieval of LDM-DOs may be performed in queries and by means of subscription. A subscription will result in automatic notifications of selected LDM-DOs either in defined time intervals or event driven.

This Technical Specification introduces the usage of LDMs and specifies the LDM for global usage in C-ITS.

Initial implementations of LDMs were in the EU research projects CVIS[32] and Safespot[34].

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# Intelligent transport systems — Cooperative systems — Definition of a global concept for Local Dynamic Maps

## 1 Scope

This Technical Specification

- describes the functionality of a "Local Dynamic Map" (LDM) in the context of the "Bounded Secured Managed Domain" (BSMD), and
- specifies
  - general characteristics of LDM Data Objects (LDM-DOs) that may be stored in an LDM, i.e. information on real objects such as vehicles, road works sections, slow traffic sections, special weather condition sections, etc. which are as a minimum requirement location-referenced and time-referenced,
  - service access point functions providing interfaces in an ITS station (ITS-S) to access an LDM for
    - secure add, update, and delete access for ITS-S application processes,
    - secure read access (query) for ITS-S application processes,
    - secure notifications (upon subscription) to ITS-S application processes, and
    - management access,
      - secure registration, de-registration, and revocation of ITS-S application processes at LDM, and
      - secure subscription and cancellation of subscriptions of ITS-S application processes,
  - procedures in an LDM considering
    - means to maintain the content and integrity of the data store, and
  - mechanisms supporting several LDMs in a single ITS station unit.

## 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for 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 21217, *Intelligent transport systems — Communications access for land mobiles (CALM) — Architecture*

ISO/IEC 8824-1:2008, *Information technology — Abstract Syntax Notation One (ASN.1): Specification of basic notation — Part 1*

ISO/IEC 8825-2:2008, *Information technology — ASN.1 encoding rules: Specification of Packed Encoding Rules (PER) — Part 2*

ISO 24102-3, *Intelligent transport systems — Communications access for land mobiles (CALM) — ITS station management — Part 3: Service access points*

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## 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

**3.1**
**data integrity**
property that data has not been altered or destroyed in an unauthorized manner

[SOURCE: ISO 24534-5]

**3.2**
**International Atomic Time**
time since 00:00:00 UTC, 1 January, 2004, identical with UTC except that no leap seconds need to be added

**3.3**
**LDM area of interest**
location requirement used in the filter process of queries and automatic notifications

**3.4**
**LDM area of maintenance**
information on the operational location area of an LDM used by LDM maintenance

Note 1 to entry: Reference [22] restricts the LDM Area of Maintenance to "geographical area specified by the LDM for LDM maintenance"

**3.5**
**LDM permissions**
information on how a specific ITS-S application process may use an LDM

**3.6**
**LDM data object**
location-referenced and time-referenced representation of a real object that is self-explanatory without any further context information

**3.7**
**LDM data object ID**
identifier of an LDM data object which is unique in an LDM

**3.8**
**LDM data dictionary**
dictionary of LDM data object types

**3.9**
**LDM data object type**
identifier of the type of information contained in an LDM data record

**3.10**
**location validity**
information indicating a location at which an LDM data object is valid

**3.11**
**time validity**
information indicating a time interval during which an LDM data object is valid

**3.12**
**LDM time of interest**
time requirement used in the filter process of queries and automatic notifications

**3.13**
**Local Dynamic Map**
entity consisting of LDM data objects, services, and interfaces for manipulating these LDM data objects

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**3.14**
**location reference**
uniquely identifiable description of position or area in the real world

**3.15**
**metadata**
data about data

Note 1 to entry: The term "metadata" is ambiguous as it is used for fundamentally different concepts. Structural metadata are information related to the design and specification of data structures; it is also referred to as "data about the containers of data". Descriptive metadata are information on instances of data, i.e. the data content; it is also referred to as "data about data content".

[SOURCE: ISO 19115]

**3.16**
**time of creation**
time when an LDM data record was created and updated

**3.17**
**time of deletion**
time when an LDM data record may be deleted and will no more be considered by the LDM search functionality

**3.18**
**time of generation**
time when the content of the LDM data object information field was created

Note 1 to entry: This is different to the time when the LDM data object was written into an LDM.

## 4 Symbols and abbreviated terms

| | |
|---|---|
| BSMD | Bounded Secured Managed Domain |
| BSME | Bounded Secured Managed Entity |
| IAT | International Atomic Time |
| ICS | Implementation Conformance Statement |
| ITS | Intelligent Transport Systems |
| ITS-SU | ITS Station Unit |
| IUT | Implementation Under Test |
| LDM | Local Dynamic Map |
| LDM-DD | LDM Data Dictionary |
| LDM-DT | LDM Data Type |
| LDM-DAT | LDM Data Attribute Type |
| LDM-DATID | LDM-DAT Identifier |
| LDM-DTID | LDM-DT Identifier |
| NoO | Notification of Obligations |
| OoT | Obligation of Trust |

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| | |
|---|---|
| PMI | Privilege Management Infrastructure |
| SAO | Signed Acceptance of Obligations |
| SUT | System Under Test |
| TPEG | Transport Protocol Experts Group |
| UTC | Universal Time Coordinated |

# 5 Architectural environment

## 5.1 General

This Clause contains informative descriptions of the architectural environment of an LDM.

## 5.2 Local Dynamic Map

A Local Dynamic Map (LDM) is an entity consisting of LDM Data Objects (LDM-DO), services, and interfaces for manipulating these LDM Data Objects. LDM-DOs are distinguished by means of their LDM Data object Type (LDM-DT). LDM-DTs are specified by registration in an LDM Data Dictionary (LDM-DD). The concept of the LDM-DD is specified in Annex B.

NOTE In Reference [17], LDM-DOs are classified into Type 1 (static permanent data objects, e.g. cartographic data[5]), Type 2 (static transitory data objects, e.g. temporary parking lot on the road[5]), Type 3 (dynamic transitory data objects, e.g. works location), and Type 4 (highly dynamic data objects, e.g. location, orientation, and speed of surrounding vehicles). This classification is not used in this Technical Specification.

An LDM-DO provides information on real objects (cars, road events, etc.) that are existent at a defined location, e.g. in a defined geo-area and within a defined time interval. In the uppermost simple case, the information provided by an LDM-DO is just its type, its geo-location, and its time interval of validity. Such information may be received in an ITS station unit via different channels such as

— DATEX II, TPEG, RDS-TMC (legacy systems),[30][26] and

— CEN/ETSI/ISO/SAE ITS message sets,[22][21]

composed of different sets of attributes, and presented in different formats (encodings). ITS-S application processes capable to receive this information perform a mapping on LDM-DOs and a translation of attribute formats into the common format given by the LDM-DTs.

## 5.3 LDM in an ITS-S

The Local Dynamic Map (LDM) specification provided in this Technical Specification is designed for the architectural environment of an ITS station operated as a Bounded Secured Managed Domain (BSMD) specified in ISO 21217 and illustrated in Figure 1.

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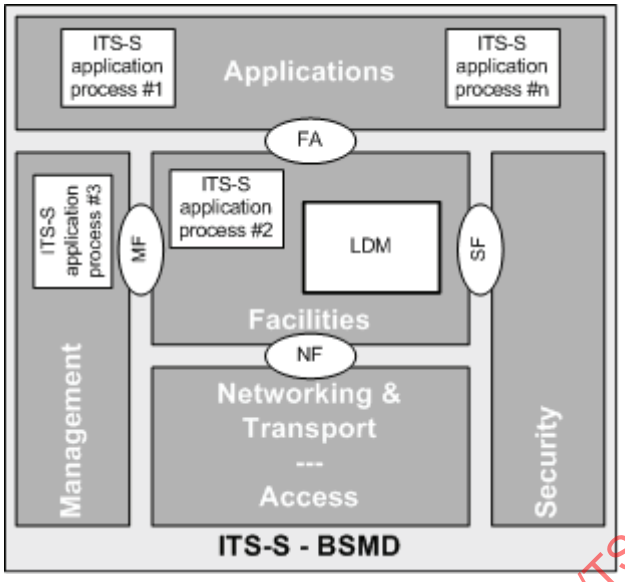


**Figure 1 — LDM in an ITS-S operated as a Bounded Secured Managed Domain (BSMD)**

The LDM functionality specified in Clause 6 is located in the ITS-S facilities layer. An LDM interfaces with ITS-S application processes specified in ISO 21217. The interface functionality is specified in 6.6.2 by means of functions of services of the FA-SAP and the MF-SAP; both service access points (SAPs) offer identical functions for this purpose. The generic services of FA-SAP and MF-SAP are specified in ISO 24102-3.

## 5.4 LDM in an ITS-SU

Various examples of supported implementation configurations are illustrated in Figure 2, Figure 3, Figure 4, and Figure 5.

Figure 2 illustrates a "single-box" configuration of an ITS station unit (ITS-SU) with a single LDM.

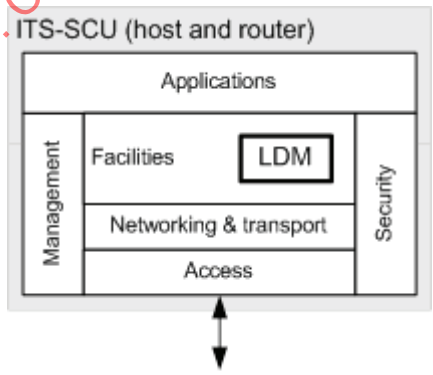


**Figure 2 — Implementation configuration example a)**

Figure 3 illustrates a "single-box" configuration of an ITS-SU with two LDMs.

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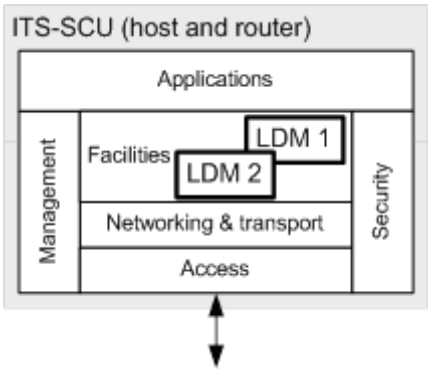


**Figure 3 — Implementation configuration example b)**

Figure 4 illustrates a configuration of an ITS-SU with two ITS station communication units (ITS-SCU). One of these ITS-SCUs has a host-only role specified in ISO 21217 and contains a single LDM. The other ITS-SCU has a router-only role specified in ISO 21217 and does not contain an LDM.

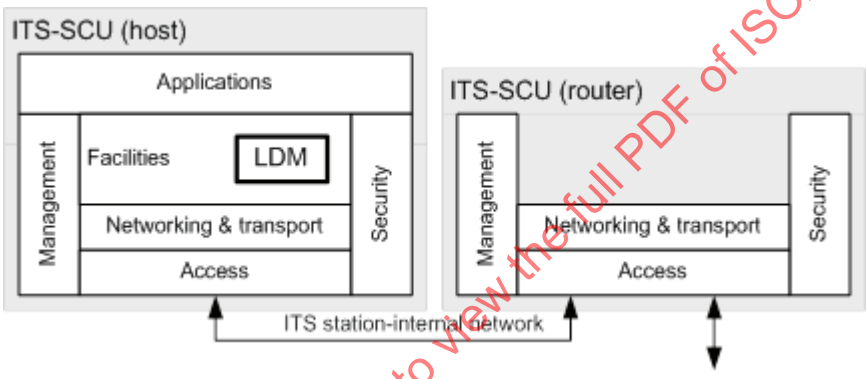


**Figure 4 — Implementation configuration example c)**

Figure 5 illustrates a configuration of an ITS-SU with two ITS station communication units (ITS-SCU). One of these ITS-SCUs has a host-only role specified in ISO 21217 and contains a single LDM. The other ITS-SCU has a host-and-router role specified in ISO 21217 and contains also an LDM.

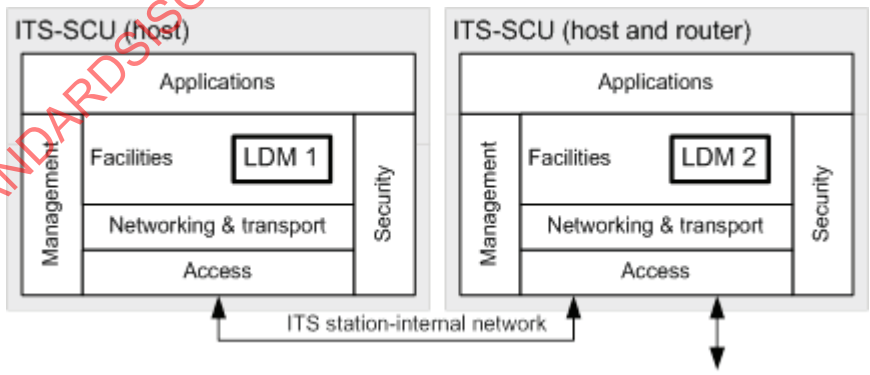


**Figure 5 — Implementation configuration example d)**

Many other implementation configurations are feasible.

NOTE In ITS-SUs composed of several ITS-SCUs, the ITS station management can use the "ITS station-internal management communications protocol" (IICP)[11] to support overall station management

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## 5.5 LDM-related processes

### 5.5.1 Synchronization of LDMs

The concept of synchronization of LDMs is introduced in Reference [17], distinguishing

— synchronization of LDMs operated in ITS station units of different vehicles, and

— synchronization of LDMs operated in ITS station units at the roadside, in central offices, and in vehicles.

Reference is made to means which are already in use for TPEG and DATEX.

Such synchronization means updating of an LDM by an authorized "master" LDM. As only ITS-S application processes can access LDM-DOs, any synchronization is to be realized by ITS applications. Details are outside the scope of this Technical Specification.

NOTE Updates of information in an ITS-SU can be performed using remote management standardized in Reference [10].

### 5.5.2 Archiving of LDM Data Objects

Archiving of LDM Data Objects is a feature that produces a kind of log-file of an LDM. Such log-file information might be of interest for different purposes, but might also be subject to privacy considerations.

This Technical Specification specifies neither an archiving functionality nor related interfaces. Archiving can be implemented in a non-standardized way.

## 5.6 LDM for road safety and vehicle-to-vehicle applications

An LDM dedicated to usage for road safety and vehicle-to-vehicle applications (electronic horizon) is specified by ETSI in Reference [22]. This ETSI LDM specification constitutes a functional sub-set of the specification provided in this Technical Specification.

## 5.7 Security perspective

### 5.7.1 Authorized access to LDM

The architecture of an LDM in the context of BSMD from a security perspective is to ensure that access is restricted to identified and authorized ITS-S application processes. Application processes not certified for operation in a BSMD may access an LDM via a secure gateway described in ISO 21217, where the firewall ITS-S application process of this gateway is authorized for read-access to the LDM.

All the core assets are to be considered as vulnerable and therefore subject to protection, where protection takes the form of specific guards. The guard mechanism used in protecting the LDM is a policy-based access control scheme where ITS-S application processes will pre-register their policy with the ITS-S, and if that policy is agreed, all future access by the ITS-S application process will be verified as being consistent with the policy.

### 5.7.2 Initialisation and installation of applications to the BSMD

The kernel of an ITS-SCU forms a trust centre of the BSME and is identifiable to third-party ITS-S application processes as such. Any ITS-S application process to be added to an ITS-SCU within the BSME verifies the identity and capability of the ITS-SCU prior to installation. If installation is allowed, an ITS-SCU verifies the credentials offered by the ITS-S application process. Prior to distribution, each ITS-S application process is functionally verified and tested and assertions of required functionality, of developer identity, and of the tester are validated prior to installation.[18]

The core model follows that developed in the i-Tour project[33] as an extension of an "Obligation of Trust" (OoT) protocol, extending the models used for Java midlet distribution used in many common application

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stores.[18] The protection framework is a form of a Privilege Management Infrastructure (PMI) based on common cryptographic modules and processing where authorization is viewed as a set of mutually agreed actions through the assignment of permissions to the parties, i.e. the LDM and the LDM user. In the OoT protocol, the participating parties exchange difficult-to-repudiate digitally signed obligating constraints, also referred to as "Notification of Obligations" (NoO), which detail their requirements for sending their sensitive information to the other party, and proof of acceptances, also referred to as "Signed Acceptance of Obligations" (SAO), which acknowledge the conditions they have accepted for receiving the other party's sensitive information. The required capabilities of the LDM user, i.e. an ITS-S application process, to be installed will be declared and the application restricted to use only those capabilities by means of a policy enforcement engine acting in the role of a Policy Enforcement Point in the LDM itself.

For protection of data, the data objects identified below capture the primary policy elements:

— PrivacyPolicyDirective;

— SecurityPolicyDirective;

— SignedPrivacyPolicy;

— SignedSecurityPolicy;

— CounterSignedPrivacyPolicy;

— CounterSignedSecurityPolicy.

The privacy policy directive is a set of policy statements that identify the identity of the data controller. The privacy enforcement point agrees to implement the policy and to indicate that in the Signed Privacy Policy where the signature is of the data processor (acting as policy enforcement point).

Acceptance of the privacy policy is notified by the client in the Countersigned Privacy Policy where the signature is given by the client using the pseudonymous identity agreed during registration. The retention of the countersigned policy agreement provides the basis of non-repudiation of consent.

NOTE The data privacy legislation in Europe assumes the presence of a number of entities in a system dealing with private data. These are the data controller, data processor and data subject, and a contract of consent. In an all-informed C-ITS, there is no a priori consent establishment between the transmitting ITS-SU and any of the receiving ITS-SUs, thus, the security model attempts to minimize the possibility of any personal data being made known to a receiving ITS-SU. The model therefore virtualizes the functionality of data controller, data processor, and consent by use of verifiable proofs of authority to act on data.

Permissions resulting from policy are of type "Permit" and "Deny" based on authorization, i.e. after application of the policy, the request is either permitted or denied. Requests themselves may contain specific access requests, e.g. read data from the LDM, write data to the LDM.

Every incoming command to the LDM is associated with a set of claims that are checked against the local policy at the PEP in the LDM. If any data access attempt from an application is made post-registration and post-acceptance of the policy that does not comply with the policy, it is denied.

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### 5.7.3 Privacy

The C-ITS enforces pseudonymity capabilities through the security functions described in ETSI/TS 102 940[24] and ETSI/TS 102 941[25] which maintains privacy control of data entered into the LDM.

## 5.8 LDM versus other similar functionalities in an ITS-SU

The sharing of data between ITS-S application processes in an ITS-SU can be achieved by subscribe/publish mechanisms, where at least two mechanisms are distinguished, i.e.

a) one allowing ITS-S application processes to subscribe at the ITS-S facilities layer to standardized messages from ITS message sets as specified in[19] without using an LDM, and

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b) one using a Local Dynamic Map (LDM) as repository of standardized data objects.

The approach a)[19] standardizes an ITS-S facility layer message handler which can

— directly forward complete received messages to subscribed ITS-S application processes without storing these messages, and

— present LDM Data Objects to an LDM in case these LDM Data Objects are contained in messages that follow the message format convention of this message handler.

There may be also other data storages, which are basically different to an LDM, i.e. which may store data objects that are not following the definition of an LDM-DO.

# 6 Functionality

This Clause contains informative descriptions of the functionality of an LDM.

## 6.1 General definitions and conventions

As explained in 5.2, an LDM deals with information on real objects that are existent at a defined location (geo-area) and within a defined time interval. Such information on a real object is identified in an **LDM Data Record** (see Figure 7). Every LDM Data Record is identified with a unique LDM Data Record ID; the value zero indicates an "unknown record".

Different location and time definitions are used to define the functionality of an LDM.

— Definitions related to the information on the real object:

  — **Location Validity**

  Information at which geo-location or in which geo-area the LDM-DO applies.

  — **Time Validity**

  Information in which time interval(s) the LDM-DO applies.

  — **Time of Generation**

  Information on the time when the LDM-DO information was generated, e.g. time when a perception system (e.g. a sensor) detected the event "slippery road".

  — **Time of Mandatory Deletion**

  Information on time after which the LDM record will no longer be returned in a query.

— Definitions used in queries:

  — **LDM Area of Interest**

  Geo-location(s) or geo-area(s) that are of interest for the querying ITS-S application process.

  — **LDM Time of Interest**

  Time instant or time interval(s) that are of interest for the querying ITS-S application process.

  — **Age of Interest**

  Age of LDM record as required by the querying ITS-S application process. The age is calculated with a numerical operator presented by the ITS-S application process against the time of generation of an LDM-DO, if available, or alternatively against the time of last update of an LDM-DO.

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— Definitions used for maintenance purposes:

  — **LDM Area of Maintenance**

  Geo-area(s) considered by the LDM search functionality and defined by the LDM in an implementation-specific way. Without overlap of the LDM Area of Interest with the LDM Area of Maintenance, a query will not result in a hit. Note that the area of maintenance can be defined relative to the momentary location of the host ITS-S.

  — **LDM Inactive Area**

  Geo-area(s) considered by the LDM to store LDM records with are not considered by the search functionality; there is no overlap between the LDM Area of Maintenance and the LDM Inactive Area. Details on the usage of the LDM Inactive Area are not specified in this Technical Specification.

  — **Time of Creation**

  Time at which the LDM record was created in the LDM Data Storage.

  — **Time of Deletion**

  Time after which an LDM record may be deleted and will no more be considered by the LDM search functionality.

Several location reference systems and time reference systems are known; examples are presented in Annex D and Annex E. This Technical Specification supports any kind of reference system by defining time reference and location reference with the ASN.1 type CLASS which allows defining specific instantiations at a later time according to the needs of C-ITS services. The generic approach for location is given in the ASN.1 type LDMarea. The generic approach for time is given in the ASN.1 type TimeInformation.

In order to manage time, an LDM needs to maintain or access a time reference system (clock). This Technical Specification assumes that there is a trusted time service available in an ITS-SU which can be used in an implementation-specific way. Time synchronization with an external clock to ensure unique time information in all ITS-SUs will be a task of the ITS-S management.

Similarly, it is assumed that an LDM has access to a service providing continuously the kinematic state of the ITS-SU in which it resides; thus, no explicit interface to such a service is specified in this Technical Specification.

As this Technical Specification supports various implementation architectures illustrated in 5.4, ITS-S application processes need to be enabled to select appropriate LDMs. For this purpose,

a) LDMs are identified by an LDM ID that is unique in an ITS-SU,

b) LDMs register at the ITS-S management entity reporting about their capabilities in terms of supported LDM-DOs, and

c) ITS-S application processes register at the ITS-S management entity reporting their LDM requirements in terms of required LDM-DOs, which is acknowledged by providing the address information of the best-suited LDMs.

The LDM performs the following procedures to maintain integrity of the LDM Data Storage:

— removal of LDM Data Records that are out of date;

— removal of LDM Data Records which are out of the LDM Area of Maintenance.

Further integrity checking is supposed to be performed by ITS-S application processes.

## 6.2 Structure of an LDM

An LDM is composed of functional blocks presented in Figure 6.

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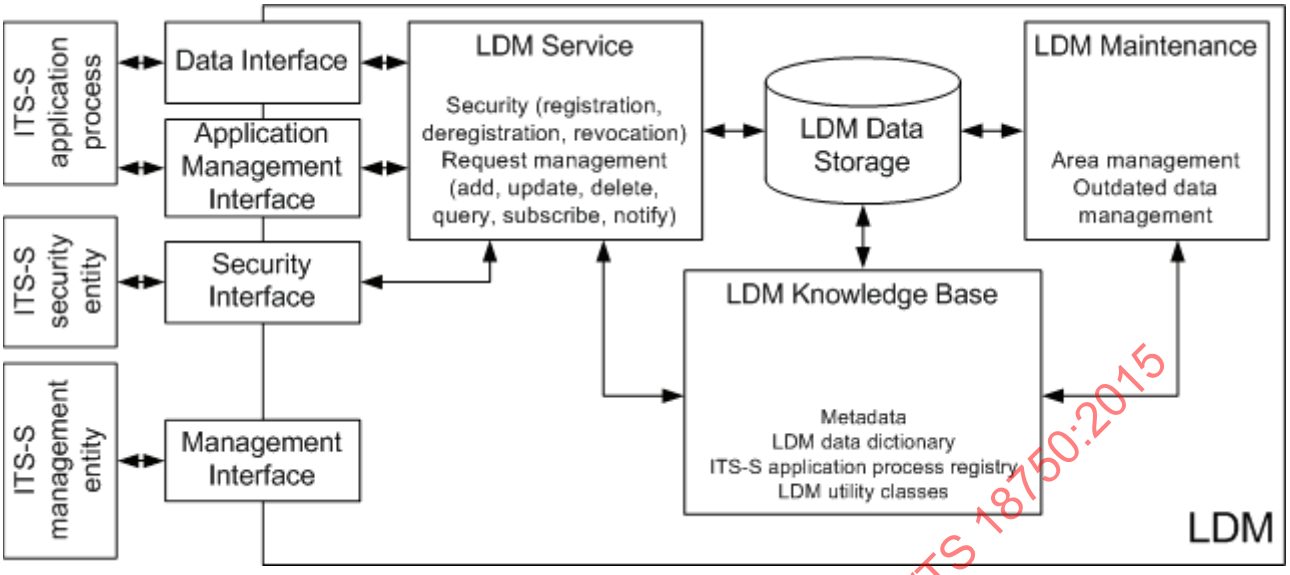


**Figure 6 — Structure of an LDM**

— **LDM Data Storage**: This is the entity in an LDM that stores LDM-DOs as described in 6.3.

— **LDM Service**: This functional block provides means for

  — managing registration, deregistration requests, and revocation of ITS-S application processes,

  — security checking in access requests, and

  — managing access requests (add, update, delete, subscribe, query, notify) from ITS-S application processes

as described in 6.4.

— **LDM Maintenance**: This functional block provides means for

  — updating the LDM Area of Maintenance, and

  — removing LDM Data Records

as described in 6.5.

— **LDM Knowledge Base**: This provides the knowledge that is required in the LDM for internal processing as described in 6.6. This functional block includes

  — Metadata,

  — the LDM Data Dictionary,

  — information on ITS-S application processes' registrations and subscriptions to the LDM, and

  — LDM utility functions.

— **Interfaces**: The interfaces used and offered by an LDM are the following.

  — Data interface towards ITS-S application processes for

    — add, update, and delete access,

    — query access,

    — subscription access, and

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  - notifications upon subscription.
- Management and security interfaces for
  - registration, deregistration, and revocation of ITS-S applications,
  - validation of access rights claimed by ITS-S applications at time of registration, and
  - LDM management (e.g. registration of LDM at the ITS-S management)

as described in 6.6.2.

- **LDM Management**: This functional block provides means for
  - registration of an LDM at the ITS-S management.

## 6.3 LDM Data Storage

An LDM Data Storage logically contains LDM data records presented in Figure 7.

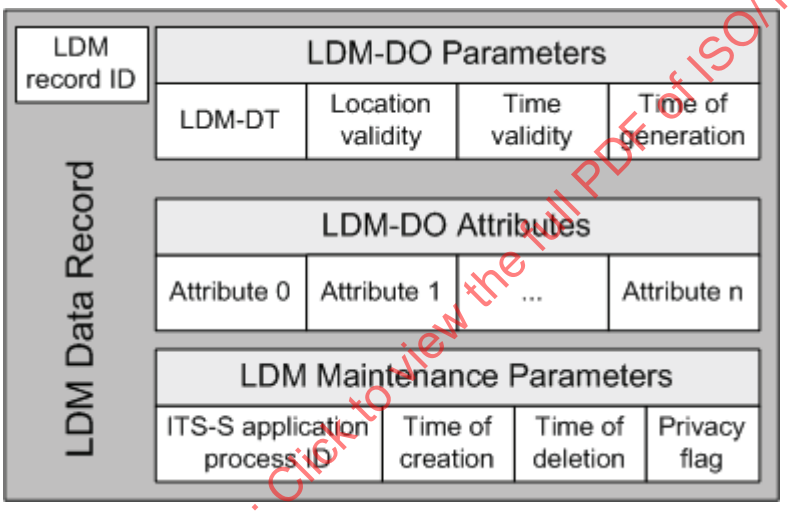


**Figure 7 — Elements of LDM Data Record**

An LDM data record is uniquely identified by its LDM record ID. An LDM data record consists of

- **LDM-DO Parameters:**
  - the LDM-DO Type (LDM-DT);
  - the Location Validity of the real object;
  - the Time Validity of the real object;
  - Time of Generation of information contained in the LDM-DO (set to the value zero in case the time is unknown);
  - Time of Mandatory Deletion of an LDM Data Record.

  NOTE 1 Updates of an LDM Data Record can only be provided by the same ITS-S application process that originally generated the LDM Data Record.

  NOTE 2 The Location Validity and Time Validity fields basically consist each of two parts, one containing the values of the original reference system and the other one containing the values of the reference system used in the LDM.
- the **LDM-DO Attributes** as specified in the LDM Data Dictionary (LDM-DD).

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— **LDM Maintenance Parameters** which cannot be set explicitly by an ITS-S application process and which cannot be retrieved by an ITS-S application process:

  — identifier of the ITS-S application process that presented this instantiation of an LDM-DO for storing in the LDM;

  — Time of Creation of the LDM Data Record which is different to the time of generation of the information contained in the attributes of the LDM-DO;

  — Time of Deletion of the LDM Data Record from the LDM;

  — Privacy flag.

Table 1 explains and specifies the elements of an LDM Data Record in Figure 7; it refers to ASN.1 type definition specified in Annex A.

**Table 1 — LDM Data Record elements**

| Element | Specification and explanation |
|---|---|
| LDM record ID | This element uniquely identifies a specific record in the LDM. The format of this element is given by the ASN.1 element `LDMrecordID` specified in Annex A. The value zero points to the "non-existent" LDM Data Record. |
| LDM-DO type | This element uniquely identifies the type of the LDM-DO. The format of this element is given by the ASN.1 element `LDMdataObjectTypeID` specified in Annex A. |
| Location Validity | This element uniquely identifies the position or area at which the information given by the LDM-DO applies. Several location reference systems are allowed in the interface functions. This field basically consist of two parts, one containing the values of the original reference system and the other one containing the values of the reference system used in the LDM. The format of location reference systems is given by the ASN.1 element `LDMarea` specified in Annex A. |
| Time Validity | This element uniquely identifies the time period when the information given by the LDM-DO applies. Several time formats to present a time period are allowed in the interface functions. Thus, this field basically consist of two parts, one containing the values of the original reference system and the other one containing the values of the reference system used in the LDM. The format of time reference systems is given by the ASN.1 element `TimeInformation` specified in Annex A. |
| Time of Generation | This element uniquely identifies the time when the data contained in the LDM-DO was generated. Note that this is different to the time of creation when the LDM Data Record was stored in the LDM. The format of this element is given by the ASN.1 element `TimeOfGeneration` specified in Annex A. |
| Time of Mandatory Deletion | This element is used to indicate up to which time the LDM Data Record may be maintained in the LDM. After this time, the LDM Data Record has to be removed from the LDM. This allows ITS-S applications to request timely deletion of LDM Data Records due to, for example, privacy regulations or privacy policies. The format of this element is given by the ASN.1 element `TimeOfDeletion` specified in Annex A. |
| LDM Data Object | This element is an instance of the LDM-DT as specified in the LDM-DD. The format of this element is given by the ASN.1 element `LDMdataObject` specified in Annex A. |
| ITS-S application process ID | This is the identifier of the ITS-S application process specified in Table 2 that presented the LDM-DO to the LDM. The format of this element is given by the ASN.1 element `ApplicationID` specified in Annex A. |
| Time of Creation | This element identifies two time events, i.e. the time when the LDM Data Record was added to the LDM and the time when an existing record was updated. The format of this element is given by the ASN.1 element `TimeOfCreation` specified in Annex A. |

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**Table 1** *(continued)*

| Element | Specification and explanation |
|---|---|
| Time of Deletion | Time of Deletion of an LDM Data Record from an LDM is identical with Time of Mandatory Deletion, if set by an ITS-S application process, or may be derived from the element Time Validity. This time information indicates the time from which the LDM Data Record will no more be disclosed to ITS-S application processes and may be archived and deleted from the data store. In case Time of Mandatory Deletion is set, archiving is prohibited. The format of this element is given by the ASN.1 element `TimeOfDeletion` specified in Annex A. |
| Privacy flag | This element is a Boolean flag indicating with the true-value that the LDM Data Record has to be deleted once Time of Deletion passed. The privacy flag may be set by different means. In case Time of Mandatory Deletion is presented with a valid value, the privacy flag is set to true. Default value is false. The format of this element is given by the ASN.1 element `PrivacyFlag` specified in Annex A. |

## 6.4 LDM services

### 6.4.1 Registration, deregistration, and revocation of ITS-S application processes

An ITS-S application process (see 5.7) presents security credentials together with a list of permissions at time of registration at an LDM. An LDM uses services of the ITS-S security entity to check the validity of claimed permissions through the registration and verification of the access control policy for the application.

Security services in the ITS-S security entity continuously check whether an authorization of an ITS-S application process needs to be revoked completely or in parts.

An ITS-S application process may also deregister from an LDM, which disables subsequent attempts to use the LDM.

A normative specification of the related procedure is presented in 7.1.1.

### 6.4.2 Security checking in access requests

Every access request to the LDM (see 6.4.3) is associated with a set of claims that are checked against the local policy at the PEP in the LDM. If any data access attempt from an application is made post-registration and post-acceptance of the policy that does not comply with the policy, it is denied.

A normative specification of the related procedure is presented in 7.1.2.

### 6.4.3 Access request management

#### 6.4.3.1 Overview

Request management includes the following:

— add an LDM Data Record as described in 6.4.3.2;

— update an LDM Data Record as described in 6.4.3.3;

— delete an LDM Data Record as described in 6.4.3.4;

— query LDM-DOs as described in 6.4.3.5;

— subscribe and unsubscribe for updates of LDM-DOs as described in 6.4.3.6;

— notify updates of LDM-DOs as described in 6.4.3.8.

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As part of the request management, filtering is applied in queries and in subscriptions. ITS-S application processes present the properties upon which queries and subscriptions are performed. First-level filtering uses the following parameters presented in Figure 7:

— LDM-DO ID, record ID;

— LDM-DT;

— LDM Area of Interest, e.g. absolute area or area relative to position and movement of ITS-SU;

— LDM Time of Interest;

— Age of Interest;

— any combination of the above-listed properties applying simultaneously (logical AND).

A second-level filter process selects those pre-filtered LDM-DOs with attribute values that meet requested conditions as described in 6.4.3.9.

NOTE For some applications, e.g. crash avoidance, it is necessary to track the movement of a real object. Such trajectories can be produced by ITS-S application processes based on LDM-DOs related to this real object.

#### 6.4.3.2 Add LDM data record

Upon successful registration at an LDM (see 6.4.1), an ITS-S application process may request adding of an LDM data record to the LDM using the interface function of ASN.1 type `LDMaddRequest` specified in 6.7.4.1. In case the ITS-S application process is permitted to add an LDM-DO of a specific LDM-DT, the request is granted and the LDM Data Record is created. This request is acknowledged with the interface function of ASN.1 type `LDMaddConfirm` specified in 6.7.4.1, returning the LDM record identifier of ASN.1 type `LDMrecordID`.

A normative specification of the related procedure is presented in 7.1.3.1.

#### 6.4.3.3 Update LDM data record

An ITS-S application process that successfully requested adding of an LDM data record to the LDM (see 6.4.3.2) may subsequently update the LDM data record identified by the LDM record identifier using the interface function of ASN.1 type `LDMupdateRequest` specified in 6.7.4.2. This request is acknowledged with the interface function of ASN.1 type `LDMupdateConfirm` specified in 6.7.4.2.

A normative specification of the related procedure is presented in 7.1.3.3.

#### 6.4.3.4 Delete LDM data record

An ITS-S application process that successfully requested adding of an LDM data record to the LDM (see 6.4.3.2) may subsequently delete the LDM data record identified by the LDM record identifier using the interface function of ASN.1 type `LDMdeleteRequest` specified in 6.7.4.3. This request is acknowledged with the interface function of ASN.1 type `LDMdeleteConfirm` specified in 6.7.4.3.

A normative specification of the related procedure is presented in 7.1.3.4.

#### 6.4.3.5 Query LDM-DO

Upon successful registration at an LDM (see 6.4.1), an ITS-S application process may request retrieval of LDM-DOs from the LDM using the interface function of ASN.1 type `LDMqueryRequest` specified in 6.7.4.6. In case the ITS-S application process is permitted to query LDM-DOs of the specific LDM-DT, the request is granted and LDM-DOs of the requested LDM-DT are retrieved with the interface function of ASN.1 type `LDMqueryConfirm` specified in 6.7.4.6, considering the filter parameters presented in the request.

A normative specification of the related procedure is presented in 7.1.3.5.

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#### 6.4.3.6 Subscribe for updates of LDM-DOs

Upon successful registration at an LDM (see 6.4.1), an ITS-S application process may request subscription to updates of LDM-DOs from the LDM using the interface function of ASN.1 type `LDMsubscribeRequest` specified in 6.7.4.5. In case the ITS-S application process is permitted to subscribe to automatic notifications of updates of LDM-DOs of the specific LDM-DT, the request is granted and acknowledged with the interface function of ASN.1 type `LDMsubscribeConfirm` specified in 6.7.4.5. Upon updates of LDM-DOs subject to a subscription, these updates will be notified automatically to the ITS-S application process.

A normative specification of the related procedure is presented in 7.1.3.6.

#### 6.4.3.7 Unsubscribe for updates of LDM-DOs

Upon successful subscription for updates of LDM-DOs, an ITS-S application process can unsubscribe from the subscription using the interface function of ASN.1 type `ldmUnsubscribe` specified in 6.7.4.5. This request is acknowledged with the interface function of ASN.1 type `ldmUnsubscribeConf`.

A normative specification of the related procedure is presented in 7.1.3.7.

#### 6.4.3.8 Notify updates of LDM-DOs

Upon successful subscription for updates of LDM-DOs (see 6.4.3.6), an ITS-S application process will be notified about updates of LDM-DOs with the interface function of ASN.1 type `ldmNotify` specified in 6.7.4.7. This notification is not acknowledged by the ITS-S application process.

A normative specification of the related procedure is presented in 7.1.3.8.

#### 6.4.3.9 Second-level filtering

Second-level filtering is applied to values of attributes of LDM-DOs resulting from first-level filtering performed in queries and notifications of updates (see 6.4.3.5 and 6.4.3.8). The return set from the first-level filtering is further reduced to only those LDM-DOs that match the second-level attribute filter. The filtered result will be returned in the interface functions of ASN.1 types `LDMqueryConfirm` and `LDMnotifyRequest` specified in 6.7.4.6 and 6.7.4.7, respectively.

The second-level filter is a logical combination of one or more filter statements. A filter statement is a comparison statement in which an attribute from the LDM-DO is tested against a reference value. The test is defined by a comparison operator. The reference value is an absolute value of the data type of the attribute. A filter statement logically evaluates to true or false, i.e. the filter statement is true if the LDM-DO attribute matches the test and false if it fails the test. A compound filter statement is a logical operation on two filter statements. The logical operator is an AND or an OR operator. The compound statement also logically evaluates to true or false. More complex filter expressions can be constructed and presented in the filter parameter of ASN.1 type `FilterSecondLevel`.

The filter parameter of ASN.1 type `FilterSecondLevel` allows to indicate a sequence of logical operations that are combined with a logical AND (ASN.1 type `ANDsequence`), where each of these logical operations is a sequence of basic logical operations that are combined with a logical OR (ASN.1 type `ORsequence`). A basic logical operation (ASN.1 type `FilterPrimitive`) allows to present

— the unique attribute ID of the given LDM-DT,

— the numerical operation (ASN.1 type `Operators`), and

— the reference value presented as an OCTET STRING to be converted in the appropriate format.

A normative specification of the related procedure is presented in 7.1.4.

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## 6.5 LDM maintenance

### 6.5.1 LDM Area of Maintenance

The area management maintains appropriate values of the LDM Area of Maintenance. LDM-DOs which are outside the LDM Area of Maintenance may be deleted and may be archived.

NOTE The LDM Area of Interest is presented by an ITS-S application process in a query (see also 6.1).

A normative specification of the related procedure is presented in 7.2.1.

### 6.5.2 Outdated data management

The outdated data remover is in charge to delete information from the LDM which is not more valid and subject to deletion. A decision on deletion of an LDM Data Record does not require inspecting the LDM-DO.

A normative specification of the related procedure is presented in 7.2.2.

## 6.6 LDM knowledge base

### 6.6.1 Metadata

Metadata are either data on the structure of other data or on the content of data:

— location formats;

— time formats;

— additional information formats;

— LDM Data Dictionary;

— ITS-S application process registry;

— LDM Maintenance.

Such metadata are necessary for the operation of an LMD.

Registrations of ITS-S application processes as provider and user of LDM-DOs and subscriptions by ITS-S application processes for automatic notification of updates of LDM-DOs are maintained in order to ensure data integrity (only serving authorized ITS-S application processes and maintaining LDM Data Records from authorized ITS-S application processes) and support timely delivery of updates to all registered ITS-S application processes.

### 6.6.2 Utility functions

LDM utility functions perform internal processing including the following:

— LDM Data Record ID management: Creation and deletion of values ensuring uniqueness;

— spatial referencing functions:

  — translation in the method used in an LDM;

  — translation in the method requested in a query;

— time referencing functions:

  — translation in the method used in an LDM;

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  - translation in the method requested in a query;
- registration of the LDM at the ITS-S management;
- management of updates of the LDM (e.g. firmware, LDM-DD).

## 6.7 Interfaces

### 6.7.1 Types of interfaces

The LDM is accessible via interfaces illustrated in Figure 6.

Four types of interfaces applicable for the LDM are distinguished.

- **LDM application management interface** specified in 6.7.3 allowing an ITS-S application process
  - to initially register itself at an LDM and to deregister from it.
- **LDM data interface** specified in 6.7.4 allowing
  - an ITS-S application process to
    - add, update, and delete LDM Data Record into an LDM,
    - query LDM-DOs from an LDM,
    - subscribe at an LDM for automatic provisioning of LDM-DOs by this LDM, and
  - an LDM to
    - notify LDM-DOs to an ITS-S application process.
- **Security interface** specified in 6.7.5 allowing
  - an LDM to use security services to verify authorizations claimed by an ITS-S application process, and
  - security services to notify the revocation of authorizations of ITS-S application processes.
- **Management interface** specified in 6.7.6 allowing
  - an LDM to register at the ITS-S management entity and present its capabilities in terms of supported LDM-DTs, and
  - an LDM to use services from the ITS-S management entity.

### 6.7.2 Parameters of interface functions

Parameters of interface functions are presented and described in Table 2. ASN.1 details are specified in Annex A.

**Table 2 — Parameters of interface functions**

| No. | Name | ASN.1 type | Description |
|---|---|---|---|
| 1 | Age of Interest | `AgeOfInterest` | Required age of LDM-DO. Used in queries to filter time of generation (see 6.1). |
| 2 | ITS-S application process identifier | `ApplicationID` | Unique identification of an ITS-S application process for a given ITS-AID in an ITS-SU. |
| 3 | LDM Area of Interest | `AreaOfInterest` | Used in queries and in subscriptions to filter Location Validity (see 6.1). |

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**Table 2** *(continued)*

| No. | Name | ASN.1 type | Description |
|---|---|---|---|
| 4 | LDM capabilities | `LDMcapabilities` | Used at time of registration of an LDM at the ITS station management (see 6.7.6.1). |
| 5 | LDM data | `LDMinterfaceRecords` | Information returned to an ITS-S application upon a query or in a notification upon subscription. |
| 6 | LDM Data Object | `LDMdataObject` | Information presented by an ITS-S application process to be stored in an LDM Data Record. |
| 7 | LDM ID | `LDMid` | Unique identifier of an LDM in an ITS-SU. The value zero indicates an unknown LDM. |
| 8 | LDM Permissions | `LDMpermissionList` | Information on how an ITS-S application process is authorized to use an LDM.<br>Used by an ITS-S application process for registration at an LDM and by the revocation process to indicate remaining permissions.<br>Details on which LDM-DTs may be accessed are to be defined by a registration authority. |
| 9 | LDM record ID | `LDMrecordID` | LDM record identifier that is unique in an LDM. The value zero points to the "non-existent/unknown" LDM Data Record. |
| 10 | Time of Generation | `TimeOfGeneration` | Time when the information contained in an LDM Data Record was generated (see 6.1). |
| 11 | LDM Time of Interest | `TimeOfInterest` | Time instant or time interval(s) that are of interest for the querying ITS-S application process. Used in queries and in subscriptions to filter Time Validity. |
| 12 | LDM-DT ID | `LDMdataObjectTypeID` | LDM data type identifier. Used in queries. |
| 13 | List of supported LDM-DTs | `ListOfLDMDTids` | Information on the LDM Data Types contained in the local LDM-DD. Used at time of registration of an LDM at the ITS station management (see 6.7.6.1). |
| 14 | Location Validity | `LocationValidity` | Information at which geo-location or in which geo-area the LDM-DO presented by an ITS-S application applies (see 6.1). |
| 15 | Notification interval | `NotificationInterval` | Time interval between subsequent notifications upon subscription. In case the value is set to zero, notification is only applicable upon updates. Otherwise, period notification is performed disregard the setting of notification upon update. |
| 16 | Notification upon update | `NotificationUponUpdate` | Flag indicating whether notification upon update is performed or not. In case notification interval is set to zero, then notification upon update is true. |

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**Table 2** *(continued)*

| No. | Name | ASN.1 type | Description |
|---|---|---|---|
| 17 | Priority | `UserPriority` | Indicates the priority of processing a request from an ITS-S application process by the LDM. The maximum allowed value is assigned to ITS-S application process by a registry and presented to an LDM at time of registration at the LDM. |
| 18 | Reason for revocation | `RevocationReason` | Indicates reasons why permissions and priority were withdrawn or changed. |
| 19 | Result code | `ResultCode` | Indicates the result of a request. |
| 20 | Second-level filtering | `FilterSecondLevel` | Information on how to filter LDM-DO attribute values. |
| 21 | Security credentials | `LDMsecurityCredential` | Used to check LDM Permissions claimed by an ITS-S application process. |
| 22 | Subscription ID | `SubscriptionID` | Identifier of a subscription unique in an LDM. |
| 23 | Time of Mandatory Deletion | `TimeOfMandatoryDeletion` | Time information requiring deletion of an LDM Data Record (see 6.1). |
| 24 | Time Validity | `ValidityTimeInterval` | Information in which time interval(s) the LDM-DO applies (see 6.1). |

### 6.7.3 LDM application management interface

#### 6.7.3.1 Register function

The "register ITS-S application process" function with ASN.1 details specified in Annex A allows an ITS-S application process to register at an LDM for subsequent accesses. It consists of the following:

a) a request part of ASN.1 type `LDMregisterRequest` with the parameters:

   1) identifier of the ITS-S application process: ASN.1 type `ApplicationID`;

   2) identifier of an LDM: ASN.1 type `LDMid`;

   3) applicable maximum priority: ASN.1 type `UserPriority`;

   4) list of permissions: ASN.1 type `LDMpermissionList`;

   5) security credentials to verify the claimed permissions: ASN.1 type `LDMsecurityCredential`;

b) a confirm part of ASN.1 type `LDMregisterConfirm` with the parameters:

   1) identifier of the ITS-S application process: ASN.1 type `ApplicationID`;

   2) identifier of the responding LDM: ASN.1 type `LDMid`;

   3) list of confirmed permissions: ASN.1 type `LDMpermissionList`;

   4) result code: ASN.1 type `ResultCode`.

NOTE In Reference [22], similar functions are named RegistrationDataConsumer message and RegisterDataProvider message.

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#### 6.7.3.2 Deregister function

The "deregister ITS-S application process" function with ASN.1 details specified in Annex A allows an ITS-S application process to deregister from an LDM at which it was previously successfully registered. It consists of the following:

a) a request part of ASN.1 type `LDMderegisterRequest` with the parameters:

   1) identifier of the ITS-S application process: ASN.1 type `ApplicationID`;

   2) identifier of the selected LDM: ASN.1 type `LDMid`;

b) a confirm part of ASN.1 type `LDMderegisterConfirm` with the parameters:

   1) identifier of the ITS-S application process: ASN.1 type `ApplicationID`;

   2) identifier of the selected LDM: ASN.1 type `LDMid`;

   3) result code: ASN.1 type `ResultCode`.

An ITS-S application process may deregister from an LDM using the deregister function.

NOTE In Reference [22], similar functions are named DeregistrationDataConsumer message and DeregisterDataProvider message.

#### 6.7.3.3 Revoke ITS-S application process notify function

The "revoke ITS-S applicationprocess notify" function with ASN.1 details specified in Annex A allows an LDM to revoke a previously accepted registration of an ITS-S application process completely or in parts. It consists of the following:

a) a request part of ASN.1 type `LDMrevokeAppNotifyRequest` with the parameters:

   1) identifier of the ITS-S application process: ASN.1 type `ApplicationID`;

   2) identifier of the selected LDM: ASN.1 type `LDMid`;

   3) still applicable maximum priority: ASN.1 type `UserPriority`;

   4) list of still applicable permissions: ASN.1 type `LDMpermissionList`;

   5) reason for revocation: ASN.1 type `RevocationReason`;

b) a confirm part of ASN.1 type `LDMrevokeAppNotifyConfirm` with the parameters:

   1) identifier of the ITS-S application process: ASN.1 type `ApplicationID`;

   2) identifier of the selected LDM: ASN.1 type `LDMid`;

   3) result code: ASN.1 type `ResultCode`.

In case there are no more applicable permissions, this constitutes deregistration of the ITS-S application process.

NOTE In Reference [22], similar functions are named RevokeDataConsumerRegistration message and RevokeDataProviderRegistration message.

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### 6.7.4 LDM data interface

#### 6.7.4.1 Add LDM Data Record function

The "add LDM Data Record" function with ASN.1 details specified in Annex A allows a registered ITS-S application process with appropriate permissions to present an LDM-DO to be written in the LDM Data Store on an LDM. It consists of the following:

a) a request part of ASN.1 type `LDMaddRequest` with the parameters:
   1) identifier of the ITS-S application process: ASN.1 type `ApplicationID`;
   2) identifier of the selected LDM: ASN.1 type `LDMid`;
   3) the LDM data to be written: ASN.1 type `LDMdataObject`;
   4) the Location Validity: ASN.1 type `LocationValidity`;
   5) the Time Validity: ASN.1 type `ValidityTimeInterval`;
   6) the Time of Generation: ASN.1 type `TimeOfGeneration`;
   7) the Time of Mandatory Deletion: ASN.1 type `TimeOfMandatoryDeletion`;
b) a confirm part of ASN.1 type `LDMaddConfirm` with the parameters:
   1) identifier of the ITS-S application process: ASN.1 type `ApplicationID`;
   2) identifier of the selected LDM: ASN.1 type `LDMid`;
   3) LDM Data Record identifier: ASN.1 type `LDMrecordID`;
   4) result code: ASN.1 type `ResultCode`.

NOTE In Reference [22], a similar function is named AddProviderdata message.

#### 6.7.4.2 Update LDM Data Record function

The "update LDM Data record" function with ASN.1 details specified in Annex A allows a registered ITS-S application process with appropriate permissions to update an LDM Data Record that it wrote previously in the LDM Data Store. It consists of the following:

a) a request part of ASN.1 type `LDMupdateRequest` with the parameters:
   1) identifier of the ITS-S application process: ASN.1 type `ApplicationID`;
   2) identifier of the selected LDM: ASN.1 type `LDMid`;
   3) LDM record identifier of the LDM Data Record to be updated: ASN.1 type `LDMrecordID`;
   4) the LDM data to be written: ASN.1 type `LDMdataObject`;
   5) the Location Validity: ASN.1 type `LocationValidity`;
   6) the Time Validity: ASN.1 type `ValidityTimeInterval`;
   7) the Time of Generation: ASN.1 type `TimeOfGeneration`;
   8) the Time of Mandatory Deletion: ASN.1 type `TimeOfMandatoryDeletion`;
b) a confirm part of ASN.1 type `LDMupdateConfirm` with the parameters:
   1) identifier of the ITS-S application process: ASN.1 type `ApplicationID`;

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2) identifier of the selected LDM: ASN.1 type `LDMid`;

3) LDM record identifier: ASN.1 type `LDMrecordID`;

4) result code: ASN.1 type `ResultCode`

NOTE In Reference [22], a similar function is named UpdateProviderdata message.

#### 6.7.4.3 Delete LDM Data Record function

The "delete LDM Data Record" function with ASN.1 details specified in Annex A allows a registered ITS-S application process with appropriate permissions to delete a previously written or updated LDM Data Record from the LDM Data Store. It consists of the following:

a) a request part of ASN.1 type `LDMdeleteRequest` with the parameters:

1) identifier of the ITS-S application process: ASN.1 type `ApplicationID`;

2) identifier of the selected LDM: ASN.1 type `LDMid`;

3) LDM record identifier of the LDM Data Record to be deleted: ASN.1 type `LDMrecordID`;

b) a confirm part of ASN.1 type `LDMdeleteConfirm` with the parameters:

1) identifier of the ITS-S application process: ASN.1 type `ApplicationID`;

2) identifier of the selected LDM: ASN.1 type `LDMid`;

3) LDM record identifier: ASN.1 type `LDMrecordID`;

4) result code: ASN.1 type `ResultCode`.

NOTE In Reference [22], a similar function is named DeleteProviderdata message.

#### 6.7.4.4 Subscribe function

The "subscribe" function with ASN.1 details specified in Annex A allows a registered ITS-S application process with appropriate permissions to subscribe for automatic notifications of LDM-DOs from an LDM. It consists of the following:

a) a request part of ASN.1 type `LDMsubscribeRequest` with the parameters:

1) identifier of the ITS-S application process: ASN.1 type `ApplicationID`;

2) identifier of the selected LDM: ASN.1 type `LDMid`;

3) priority of the request: ASN.1 type `UserPriority`;

4) LDM record ID: ASN.1 type `LDMrecordID`;

5) LDM-DT ID: ASN.1 type `LDMdataObjectTypeID`;

6) LDM Area of Interest: ASN.1 type `AreaOfInterest`;

7) LDM Time of Interest: ASN.1 type `TimeOfInterest`;

8) age of LDM Data Record: ASN.1 type `AgeOfInterest`;

9) second-level filtering: ASN.1 type `FilterSecondLevel`;

10) notification interval: ASN.1 type `NotificationInterval`;

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11) notification upon update: ASN.1 type `NotificationUponUpdate`;

b) a confirm part of ASN.1 type `LDMsubscribeConfirm` with the parameters:

1) identifier of the ITS-S application process: ASN.1 type `ApplicationID`;

2) identifier of the selected LDM: ASN.1 type `LDMid`;

3) subscription ID: ASN.1 type `SubscriptionID`;

4) result code: ASN.1 type `ResultCode`.

Parameters a)-4) through a)-8) are used as filter parameters concatenated with a logical AND. Parameters with values indicating "no value" or "don't care" are excluded from the filter process.

NOTE In Reference [22], a similar function is named SubscribeDataConsumer message.

#### 6.7.4.5 Unsubscribe function

The "unsubscribe" function with ASN.1 details specified in Annex A allows a registered ITS-S application process with appropriate permissions to unsubscribe from a previously performed subscription for automatic notifications of LDM-DOs from an LDM. It consists of the following:

a) a request part of ASN.1 type `LDMunsubscribeRequest` with the parameters:

1) identifier of the ITS-S application process: ASN.1 type `ApplicationID`;

2) identifier of the selected LDM: ASN.1 type `LDMid`;

3) priority of the request: ASN.1 type `UserPriority`;

4) subscription ID: ASN.1 type `SubscriptionID`;

b) a confirm part of ASN.1 type `LDMunsubscribeConfirm` with the parameters:

1) identifier of the ITS-S application process: ASN.1 type `ApplicationID`;

2) identifier of the selected LDM: ASN.1 type `LDMid`;

3) subscription ID: ASN.1 type `SubscriptionID`;

4) result code: ASN.1 type `ResultCode`.

NOTE In Reference [22], a similar function is named UnsubscribeDataConsumer message.

#### 6.7.4.6 Query function

The "query" function with ASN.1 details specified in Annex A allows a registered ITS-S application process with appropriate permissions to query LDM-DOs from an LDM. It consists of the following:

a) a request part of ASN.1 type `LDMqueryRequest` with the parameters:

1) identifier of the ITS-S application process: ASN.1 type `ApplicationID`;

2) identifier of the selected LDM: ASN.1 type `LDMid`;

3) priority of the request: ASN.1 type `UserPriority`;

4) LDM record ID: ASN.1 type `LDMrecordID`;

5) LDM-DT ID: ASN.1 type `LDMdataObjectTypeID`;

6) LDM Area of Interest: ASN.1 type `AreaOfInterest`;

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7) LDM Time of Interest: ASN.1 type `TimeOfInterest`;

8) age of LDM Data Record: ASN.1 type `AgeOfInterest`;

9) second-level filtering: ASN.1 type `FilterSecondLevel`;

b) a confirm part of ASN.1 type `LDMqueryConfirm` with the parameters:

1) identifier of the ITS-S application process: ASN.1 type `ApplicationID`;

2) identifier of the selected LDM: ASN.1 type `LDMid`;

3) sequence of LDM data: ASN.1 type `LDMinterfaceRecords`;

4) result code: ASN.1 type `ResultCode`.

NOTE In Reference [22], a similar function is named RequestDataObjects message.

#### 6.7.4.7 Notification function

The "notification" function with ASN.1 details specified in Annex A allows an LDM to notify LDM-DOs to ITS-S application process that previously subscribed successfully to this notification service. It consists of the following:

a) a request part of ASN.1 type `LDMnotifyRequest` with the parameters:

1) identifier of the ITS-S application process: ASN.1 type `ApplicationID`;

2) identifier of the selected LDM: ASN.1 type `LDMid`;

3) subscription ID: ASN.1 type `SubscriptionID`;

4) sequence of LDM data: ASN.1 type `LDMinterfaceRecords`.

No confirmation is expected.

### 6.7.5 Security interface

#### 6.7.5.1 Check authorization function

The "check authorization" function with ASN.1 details specified in Annex A allows an LDM to request the Policy Enforcement Point (PEP) and Policy Decision Point (PDP) (architecturally located in the ITS-S security entity) to check whether permissions claimed by an ITS-S application process at time of registration are correctly claimed during run time. This includes checking of the maximum allowed value of priority of the ITS-S application process. It consists of the following:

a) a request part of ASN.1 type `LDMcheckAuthorizationRequest` with the parameters:

1) identifier of the ITS-S application process: ASN.1 type `ApplicationID`;

2) identifier of an LDM: ASN.1 type `LDMid`;

3) priority of the request: ASN.1 type `UserPriority`;

4) list of permissions: ASN.1 type `LDMpermission`;

5) security credentials to verify the claimed permissions: ASN.1 type `LDMsecurityCredential`;

b) a confirm part of ASN.1 type `LDMcheckAuthorizationConfirm` with the parameters:

1) identifier of the ITS-S application process: ASN.1 type `ApplicationID`;

2) identifier of the responding LDM: ASN.1 type `LDMid`;

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3) confirmed maximum priority: ASN.1 type `UserPriority`;

4) list of confirmed permissions: ASN.1 type `LDMpermissionList`;

5) result code: ASN.1 type `ResultCode`.

NOTE In Reference [22], a similar function is named Authorize message.

#### 6.7.5.2 Revoke authorization function

The "revoke authorization" function with ASN.1 details specified in Annex A allows the ITS-S security entity to notify to an LDM that authorization of an ITS-S application process is revoked completely or in parts. It consists of the following:

a) a request part of ASN.1 type `LDMrevokeAuthorizationRequest` with the parameters:

1) identifier of the ITS-S application process: ASN.1 type `ApplicationID`;

2) identifier of an LDM: ASN.1 type `LDMid`;

3) priority still applicable: ASN.1 type `UserPriority`;

4) list of still applicable permissions: ASN.1 type `LDMpermission`;

b) a confirm part of ASN.1 type `LDMrevokeAuthorizationConfirm` with the parameters:

1) identifier of the ITS-S application process: ASN.1 type `ApplicationID`;

2) identifier of the responding LDM: ASN.1 type `LDMid`;

3) result code: ASN.1 type `ResultCode`.

NOTE 1 Reasons for this revocation do not need to be disclosed to the LDM, as neither the LDM nor the affected ITS-S application process can do anything with this information.

NOTE 2 In Reference [22], a similar function is named RevokeAuthorize message.

### 6.7.6 LDM management interface

#### 6.7.6.1 LDM registration at ITS-S management entity

The "LDM register at ITS-S management" function with ASN.1 details specified in Annex A allows the LDM to register at the ITS-S management entity to notify supported LDM-DTs and capabilities. It consists of the following:

a) a request part of ASN.1 type `LDMregisterManagementRequest` with the parameters:

1) identifier of an LDM: ASN.1 type `LDMid`;

2) list of supported LDM-DTs: ASN.1 type `ListOfLDMDTids`;

3) LDM capabilities: ASN.1 type `LDMcapabilities`;

b) a confirm part of ASN.1 type `LDMregisterManagementConfirm` with the parameters:

1) identifier of the responding LDM: ASN.1 type `LDMid`;

2) result code: ASN.1 type `ResultCode`.

LDM capabilities identified so far are

— basic capabilities (`LDMcapabilities` = 0),

— electronic horizon capability ((`LDMcapabilities` = 1),

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— second-level filtering capability (`LDMcapabilities` = 2), and

— any combination of the above capabilities.

Six further distinct capabilities may be defined in the future, referenced by `LDMcapabilities` = 4, 8, 16, 32, 64, and 128.

A normative specification of the related procedure is presented in 7.5.1.

### 6.7.7 Service access points

Interfaces are implemented as functions of service primitives of service access points (SAPs) of the ITS station reference architecture specified in ISO 21217. Services and service primitives of the SAPs are specified in ISO 24102-3.

The service primitive MF-COMMAND.request is used to present a command to an LDM; it may be acknowledged with the service primitive MF-COMMAND.confirm; both specified in ISO 24102-3. ASN.1 types for the applicable functions are specified in Annex A and presented in Table 3.

**Table 3 — Functions used in the MF-COMMAND service**

| **MF-Command-request** | | |
|---|---|---|
| **&mxref** | **&MXParam (Interface function)** | **Description** |
| 100 | `LDMregisterRequest` | Implements the register request function (see 6.7.3.1). |
| 101 | `LDMderegisterRequest` | Implements the deregister request function (see 6.7.3.2). |
| 102 | `LDMaddRequest` | Implements the write request function (see 6.7.4.1). |
| 103 | `LDMupdateRequest` | Implements the update request function (see 6.7.4.2). |
| 104 | `LDMdeleteRequest` | Implements the delete request function (see 6.7.4.3). |
| 105 | `LDMsubscribeRequest` | Implements the subscribe request function (see 6.7.4.4). |
| 106 | `LDMunsubscribeRequest` | Implements the unsubscribe request function (see 6.7.4.5). |
| 107 | `LDMqueryRequest` | Implements the query function (see 6.7.4.6). |
| **MF-Command-confirm** | | |
| **&mxref** | **&MXParam (Interface function)** | **Description** |
| 100 | `LDMregisterConfirm` | Implements the register confirm function (see 6.7.3.1). |
| 101 | `LDMderegisterConfirm` | Implements the deregister confirm function (see 6.7.3.2). |
| 102 | `LDMaddConfirm` | Implements the add confirm function (see 6.7.4.1). |
| 103 | `LDMupdateConfirm` | Implements the update confirm function (see 6.7.4.2). |
| 104 | `LDMdeleteConfirm` | Implements the delete confirm function (see 6.7.4.3). |
| 105 | `LDMsubscribeConfirm` | Implements the subscribe confirm function (see 6.7.4.4). |
| 106 | `LDMunsubscribeConfirm` | Implements the unsubscribe confirm function (see 6.7.4.5). |
| 107 | `LDMqueryConfirm` | Implements the query confirm function Implements the query function (see 6.7.4.6). |

The service primitive MF-REQUEST.request is used to present a command by the LDM to the ITS-S management entity: it may be acknowledged with the service primitive MF-REQUEST.confirm; both specified in ISO 24102-3. ASN.1 types for the applicable function are specified in Annex A and presented in Table 4.

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**Table 4 — Functions used in the MF-REQUEST service**

| **MF-Request-request** | | |
|---|---|---|
| **&mxref** | **&MXParam (Interface function)** | **Description** |
| 108 | LDMrevokeAppNotifyRequest | Implements the revoke application notify request function (see 6.7.3.3). |
| 109 | LDMnotifyRequest | Implements the notify request function (see 6.7.4.7). |
| 110 | LDMregisterManagementRequest | Implements the register LDM request function (see 6.7.6.1). |
| **MF-Request-confirm** | | |
| **&mxref** | **&MXParam (Interface function)** | **Description** |
| 108 | NullType | No confirmation of the revoke application notify request function is expected. If a confirmation is presented in the SAP, the NullType function is used. |
| 109 | NullType | No confirmation of the notify request function is expected. If a confirmation is presented in the SAP, the NullType function is used. |
| 110 | LDMregisterManagementConfirm | Implements the LDM register confirm function (see 6.7.6.1). |

The service primitive SF-COMMAND.request is used to present a security command to an LDM, and acknowledged with the service primitive SF-COMMAND.confirm; both specified in ISO 24102-3. ASN.1 types for the applicable functions are specified in Annex A and presented in Table 5.

**Table 5 — Functions used in the SF-COMMAND service**

| **SF-Command-request** | | |
|---|---|---|
| **&mxref** | **&MXParam (Interface function)** | **Description** |
| 100 | LDMrevokeAuthorizationRequest | Implements the revoke authorization request function (see 6.7.5.2). |
| **SF-Command-confirm** | | |
| **&mxref** | **&MXParam (Interface function)** | **Description** |
| 100 | LDMrevokeAuthorizationConfirm | Implements the revoke authorization confirm function (see 6.7.5.2). |

The service primitive SF-REQUEST.request is used present a security command by the LDM to the ITS-S security entity, and acknowledged with the service primitive SF-REQUEST.confirm; both specified in ISO 24102-3. ASN.1 and values for the applicable functions are specified in Annex A and presented in Table 6.

**Table 6 — Functions used in the SF-REQUESTservice**

| **SF-Request-request** | | |
|---|---|---|
| **&mxref** | **&MXParam (Interface function)** | **Description** |
| 100 | LDMcheckAuthorizationRequest | Implements the check authorization request function (see 6.7.5.1). |
| **SF-Request-confirm** | | |
| **&mxref** | **&MXParam (Interface function)** | **Description** |
| 100 | LDMcheckAuthorizationConfirm | Implements the check authorization confirm function (see 6.7.5.1). |

Table 7 lists the functions of the FA-SAP service primitives applicable for this Technical Specification, with ASN.1 details specified in Annex A. These service primitives are referred to as FASAPDOWN and FASAPUP specified in ISO 24102-3.

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**Table 7 — Functions used in the FA-SAP services**

| **FASAPDOWN** | | |
|---|---|---|
| **&primitiveRef** | **&Primitive (Interface function)** | **Description** |
| 100 | LDMregisterRequest | Implements the register request function (see 6.7.3.1). |
| 101 | LDMderegisterRequest | Implements the deregister request function (see 6.7.3.2). |
| 102 | LDMaddRequest | Implements the add request function (see 6.7.4.1). |
| 103 | LDMupdateRequest | Implements the update request function (see 6.7.4.2). |
| 104 | LDMdeleteRequest | Implements the delete request function (see 6.7.4.3). |
| 105 | LDMsubscribeRequest | Implements the subscribe request function (see 6.7.4.4). |
| 106 | LDMunsubscribeRequest | Implements the unsubscribe request function (see 6.7.4.5). |
| 107 | LDMqueryRequest | Implements the query function (see 6.7.4.6). |
| 108 | NullType | No confirmation of the revoke application notify request function is expected. If a confirmation is presented in the SAP, the NullType function is used. |
| 109 | NullType | No confirmation of the notify request function is expected. If a confirmation is presented in the SAP, the NullType function is used. |
| 110 | LDMregisterManagementConfirm | Implements the LDM register confirm function (see 6.7.6.1). |
| **FASAPUP** | | |
| **&primitiveRef** | **&Primitive (Interface function)** | **Description** |
| 100 | LDMregisterConfirm | Implements the register confirm function (see 6.7.3.1). |
| 101 | LDMderegisterConfirm | Implements the deregister confirm function (see 6.7.3.2). |
| 102 | LDMaddConfirm | Implements the add confirm function (see 6.7.4.1). |
| 103 | LDMupdateConfirm | Implements the update confirm function (see 6.7.4.2). |
| 104 | LDMdeleteConfirm | Implements the delete confirm function (see 6.7.4.3). |
| 105 | LDMsubscribeConfirm | Implements the subscribe confirm function (see 6.7.4.4). |
| 106 | LDMunsubscribeConfirm | Implements the unsubscribe confirm function (see 6.7.4.5). |
| 107 | LDMqueryConfirm | Implements the query confirm function Implements the query function (see 6.7.4.6). |
| 108 | LDMrevokeAppNotifyRequest | Implements the revoke application notify request function. |
| 109 | LDMnotifyRequest | Implements the notify request function. |
| 110 | LDMregisterManagementRequest | Implements the register LDM request function (see 6.7.6.1). |

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## 7 Procedures

This Clause contains normative requirements on procedures.

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## 7.1 LDM services

### 7.1.1 Registration, deregistration, and revocation of ITS-S application processes

Secure registration shall be performed upon request presented by the "register function" specified in 6.7.3.1 with support of the ITS-S security entity requested with the "initial check of authorization function" specified in 6.7.5.1.

Deregistration shall be performed upon request presented by the "deregister function" specified in 6.7.3.2, or upon request from the ITS-S security presented in "notify revocation of authorization function" specified in 6.7.3.3.

### 7.1.2 Security checking in access requests

All attempts of an ITS-S application process to access an LDM shall be based on the policy enforcement mechanism described in 5.7, 6.4.1, and 6.4.2, which intercepts all function calls to the LDM and permits them only if the call complies with a previously registered policy.

### 7.1.3 Access request management

#### 7.1.3.1 Authorization and plausibility checking

Upon reception of an access request management interface function, the LDM shall check whether the ITS-S application process is already properly registered for the given request and whether the presented parameter values are within valid ranges (plausible). In case of failure, the request shall be confirmed with an appropriate result code:

— 3: unknown ITS-S application process;

— 5: invalid priority (priority presented is higher than the maximum allowed priority);

— 6: invalid filter (second-level filtering is not supported or an inappropriate operator was selected);

— 9: unknown LDM-DT (not supported by the LDM);

— 10: no authorization for the given request;

— 11: invalid time information (e.g. time in the past).

Alternatively, the requested action shall be performed.

#### 7.1.3.2 Add LDM Data Record

Add access shall be performed upon request presented by the "add function" of ASN.1 type `LDMaddRequest` specified in 6.7.4.1 after successful authorization checking specified in 7.1.3.1.

The LDM shall create a new LDM Data Record with a unique LDM record ID, shall set the value of the LDM record ID field to the appropriate value of this new LDM Data Record, shall set Time of Creation to the current time, shall set the values of LDM-DO type, Location validty, Time validty, Time of Generation, Time of Mandatory Deletion, LDM Data Object, ITS-S application process ID as given in the respective parameters of the request. In case the formats of Location Validity, Time Validity, Time of Generation, and Time of Mandatory Deletion are different to the format used in the LDM, an appropriate format transformation shall be performed, and both formats shall be stored.

Time of Deletion shall be set equal to Time of Mandatory Deletion, if available, or derived from Time Validity.

The Policy flag shall be set to true if Time of Mandatory Deletion is set to a valid value.

NOTE The Policy flag can also be set to true by other means that are outside the scope of this Technical Specification.

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Successful performance of the request shall be confirmed with result code = 0 (success) presented in the confirm function of ASN.1 type `LDMaddConfirm`.

#### 7.1.3.3 Update LDM Data Record

Update access shall be performed upon request presented by the "update function" of ASN.1 type `LDMupdateRequest` specified in 6.7.4.2 after successful authorization checking specified in 7.1.3.1.

The LDM shall update those fields of the LDM Data Record indicated by the unique LDM record ID. Update shall be performed on those parameters (Location validty, Time validty, Time of Generation, Time of Mandatory Deletion, LDM Data Object) of which the respective interface parameters show a valid value (different to the null value). Format transformation and storage of both formats shall be performed as specified in 7.1.3.2.

Time of Deletion shall be set equal to Time of Mandatory Deletion, if available, or derived from Time Validity.

The Policy flag shall be set to true if Time of Mandatory Deletion is set to a valid value.

NOTE The Policy flag can also be set to true by other means that are outside the scope of this Technical Specification.

Successful performance of the request shall be confirmed with result code = 0 (success) presented in the confirm function of ASN.1 type `LDMupdateConfirm`.

#### 7.1.3.4 Delete LDM Data Record

Delete access shall be performed upon request presented by the "delete function" of ASN.1 type `LDMdeleteRequest` specified in 6.7.4.3.

The LDM Data Record shall be completely removed from the active area of the LDM.

Successful performance of the request shall be confirmed with result code = 0 (success) presented in the confirm function of ASN.1 type `LDMdeleteConfirm`.

#### 7.1.3.5 Query LDM-DO

Queries shall be performed upon request presented by the "query function" of ASN.1 type `LDMqueryRequest` specified in 6.7.4.6. The "query function" implements a mandatory first-level filter function and an optional second-level filter feature as specified in 7.1.4.

First-level filtering shall be performed on the presented parameters:

— LDM record ID, if set to a valid value (different to zero);

— LDM-DT ID (compared with ID of LDM-DOs);

— LDM Area of Interest (compared with Location Validity);

— LDM Time of Interest (compared with Time Validity);

— age of LDM Data Record (compared with Time of Generation of LDM-DO, if available, or alternatively with time of last update contained in Time of Creation).

All above requirements shall be fulfilled simultaneously in order to preselect the respective LDM-DO and forward it to the optional second-level filtering.

In case the querying ITS-S application presents LDM Area of Interest or LDM Time of Interest in a format different to either the original format of Validity area and Validity time, respectively, or the format used by the LDM, an appropriate format transformation shall be performed.

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Upon successful finalization of the search in the LDM Data Storage, all hits shall be returned to the querying ITS-S application process presented in the confirm function of ASN.1 type `LDMqueryConfirm` with result code = 0 (success). In case of a failure, the appropriate result code indicating the error shall be returned.

#### 7.1.3.6 Subscribe for updates of LDM-DOs

Subscription shall be performed upon request presented by the "subscribe function" of ASN.1 type `LDMsubscribeRequest` specified in 6.7.4.4. The "subscribe function" is identical with the "query" function except that not just a single query of the LDM Data Storage is performed. Subscription shall result in either periodic notifications of available LDM-DOs, or event-driven notifications, i.e. upon available updates of LDM-DOs).

The LDM shall confirm successful acceptance of the "subscribe" request with result code 0 (success) presented in the confirm function of ASN.1 type `LDMsubscribeConfirm`.

Subsequent to this confirmation, notifications shall be performed as specified in 7.1.3.8 until the LDM receives an "unsubscribe" function as specified in 7.1.3.7.

#### 7.1.3.7 Unsubscribe for updates of LDM-DOs

Cancellation of subscription shall be performed upon request presented by the "unsubscribe function" of ASN.1 type `LDMunsubscribeRequest` specified in 6.7.4.5.

The LDM shall terminate respective notifications of updates of LDM-DOs and shall confirm this with result code 0 (success) in the confirm function of ASN.1 type `LDMunsubscribeConfirm`.

#### 7.1.3.8 Notify updates of LDM-DOs

Notification shall be restricted to successfully subscribed ITS-S applications and to authorized LDM-DOs as requested at time of subscription. Notification shall be performed with the "notification function" of ASN.1 type `LDMnotifyRequest` specified in 6.7.4.7.

An ITS-S application process shall not acknowledge such notifications.

### 7.1.4 Second-level filtering

Second-level filtering is an optional feature based on the filter interface parameter of ASN.1 type `FilterSecondLevel`. Availability of this feature shall be indicated during time of registration of the LDM (see 7.5.1).

Second-level filtering is applied to those LDM-DOs resulting from first-level filtering in query functions and subscribe functions (see 6.4.3.1, 7.1.3.5, and 7.1.3.6). The second-level filtering shall compare attribute values of the pre-selected LDM-DOs with reference values according to the filter requirements presented in the filter parameter. Reference values are presented as OCTET STRINGs. An OCTET STRING representation of a value shall be converted into the appropriate format of the respective attribute in order to allow comparison of values.

LDM-DOs that pass successfully first- and second-level filtering shall be presented to the requesting ITS-S application process.

## 7.2 LDM maintenance

### 7.2.1 Area management

The area management may delete an LDM Data Record in case its Location Validity is completely outside of the LDM Area of Maintenance. Alternatively, the LDM Data Record may be moved to an inactive area of the LDM Data Store which is not used for queries and notifications if the Privacy flag is set to false.

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In case inactive areas of the LDM Data Store are implemented, the area management shall move LDM Data Records to the active area used for queries and notifications once at least a part of the area of validity is within the LDM Area of Maintenance.

### 7.2.2 Outdated data removal

The outdated data management shall delete an LDM Data Record at a time equal to or later than the Time of Deletion given in the LDM maintenance parameters illustrated in Figure 7. In case the Privacy flag is set to false, the LDM Data Record may be stored in an inactive area of the LDM.

## 7.3 LDM knowledge database

The LDM knowledge database is, as the name says, a database.

Updates of the LDM knowledge database may be done by the ITS-SCU configuration management centre introduced in Reference [18] using ITS remote station management specified in Reference [10]. Further details are outside the scope of this Technical Specification.

The normative specification on how to create the LDM Data Dictionary is provided in Annex B.

## 7.4 Interfaces

Normative specifications of interfaces are not applicable, as all interfaces are specified in 6.6.2 as functions of service primitives of service access points (SAPs).

NOTE Service primitives may become observable PDUs, e.g. as specified for the ITS station-internal management communications protocol (IICP)[11] which is also used in conformance testing to exchange test protocol data units between the test system and the system under test.

## 7.5 LDM management

### 7.5.1 Registration of LDM at ITS-S management entity

An LDM shall register at the ITS-S management entity with the "LDM register function" of ASN.1 type `LDMregisterManagementRequest` specified in 6.7.6.1. The LDM shall present to the ITS-S management

— its LDM identifier as assigned at time of installation or update of the LDM software,

— the list of supported LDM-DTs, and

— its capabilities (see 6.7.6.1).

Successful registration will be confirmed by the ITS-S management with return status 0 (success) in the confirm function of ASN.1 type `LDMregisterManagementConfirm`.

### 7.5.2 Multiple ITS-SCUs

In case of a distributed implementation of an ITS-SU as illustrated in Figure 4 and Figure 5, the ITS-S management in the various ITS-SCUs shall communicate with each other in an appropriate way to act as a global management of the ITS-SU. This functionality may be implemented with ITS station-internal management communications (IICP) specified in Reference [11], allowing for remote management SAP access.

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# Annex A
(normative)

# ASN.1 modules

## A.1 Overview

The ASN.1 basic notation is specified in ISO/IEC 8824-1:2008. The following ASN.1 module is specified in this Annex:

— CITSldm {iso(1) standard(0) cits-ldm (18750) asnm-1 (1) version1 (1)}

## A.2 Module CITSldm

Unaligned packed encoding rules (PER) as specified in ISO/IEC 8825-2:2008 shall be applied for the ASN.1 module CITSldm in case the data elements and value elements are used in service primitives of SAPs of the ITS-SU. Encoding rules for other usage are outside the scope of the present document.

This module imports ASN.1 definitions from ASN.1 modules specified in ISO 24102-3 and References [8], [9], [18], and [22].

```
CITSldm {iso(1) standard(0) cits-ldm (18750) asnm-1(1) version1 (1)}
DEFINITIONS AUTOMATIC TAGS::=BEGIN

IMPORTS

FASAPDOWN, FASAPUP, MFSAP-CR, MFSAP-CC, MFSAP-RR, MFSAP-RC, SFSAP-CR, SFSAP-CC, SFSAP-RR,
SFSAP-RC, RefFASAPDOWN, RefFASAPUP, RefMFSAP-CR, RefMFSAP-CC, RefMFSAP-RR, RefMFSAP-RC,
RefSFSAP-CR, RefSFSAP-CC, RefSFSAP-RR, RefSFSAP-RC FROM CALMmsap { iso (1) standard (0)
calm-management (24102) msap (3) asnm-1 (1) version1 (1)}

GeoPolygonArea FROM CITSapplMgmtApplReg {iso(1) standard(0) cits-applMgmt (17419)
applRegistry (2) version1 (1)}

ApplicationID FROM CALMmanagement { iso (1) standard (0) calm-management (24102) local (1)
asnm-1 (1) version1 (1)}

UserPriority, NullType, Time48IAT FROM CALMllsap {iso(1) standard(0) calm-ll-sap(21218)
asnm-1 (1) version1 (1)}

AuthID FROM ITSldm { itu-t(0) identified-organization(4) etsi(0) itsDomain(5) wg1(1)
itsldmapi(2863) operation(0) version0(0) }

;

-- End of IMPORTS

-- Types

-- Interface parameters
-- ITS-S application process identifier
-- ApplicationID imported from ISO 24102-1

-- LDM Area of Interest
AreaOfInterest::=LDMarea

-- LDM Authorzations / permissions
LDMpermissionList::=SEQUENCE OF LDMpermission

LDMpermission::= LDMdataObjectTypeID
```

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```
-- Security credentials to check permissions

SECCRED::=CLASS {
   &ref Ref-SecCredLDM,
   &Value
   }

Ref-SecCredLDM::=INTEGER{
   c-LDMsecCred-Null       (0),
   c-LDMsecCred-AuthID     (1)
   } (0..255)


LDMsecurityCredential::=SEQUENCE{
   refSec     SECCRED.&ref({LDMsecCredentials}),
   secCred    SECCRED.&Value({LDMsecCredentials}{@refSec})
   }

LDMsecCredentials SECCRED::={noSecCred | authID, ...}

noSecCred SECCRED::={&ref c-LDMsecCred-Null, &Value NullType}
authID SECCRED::={&ref c-LDMsecCred-AuthID, &Value AuthID}


-- LDM record ID: EN 302 895 uses the name DataObjectID
LDMrecordID::=INTEGER{
   ldmRecordIDunknown      (0)
   } - value zero is reserved for the unknown record


-- LDM Data Dictionary

DataDictionaryID::=INTEGER{
   ddID-LDMdd(1) -- LDM-DD
   } -- needs to be maintained in a registry

LDMDATADICTIONARY::=CLASS {
   &ref LDMdataObjectTypeID UNIQUE,
   &Value
   }

LDMdataObjectTypeID::=INTEGER{
   c-ldmdoNull       (0) -- unknown LDM-DO type
   } (0..4294967295) -- values are registered


LDMdataObject::=SEQUENCE{
   ldmdotRef      LDMDATADICTIONARY.&ref({LDMdataObjectTypes}),
   lDMdataObType  LDMDATADICTIONARY.&Value({LDMdataObjectTypes}{@ldmdotRef})
   }

LDMdataObjectTypes LDMDATADICTIONARY::={ldmdoNull, ...}

ldmdoNull     LDMDATADICTIONARY::={&ref c-ldmdoNull, &Value NullType}

-- further types to be added as needed by real implementations

-- LDM Data Object Types consist of a sequence of zero or more attributes. Attributes are
TLV encoded, i.e. specified with ASN.1 type CLASS with a two octet reference number as
illustrated below
-- Generic LDM Data Object Type with attributes
-- LDMgenericDataObject::=SEQUENCE (SIZE(1..255)) OF LDMdataObjectAttribute

-- LDMDTA::=CLASS {
--    &ref Ref-LDMDOattributeID,
--    &Value
--    }
--
-- LDMDOattributeID::=INTEGER{
--   c-ref0  (0)
```

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```
--   }
--
-- LDMdataObjectAttribute::=SEQUENCE{
--    ldmdotRef  LDMDTA.&ref({LDMdataObjectAttributes}),
--    lDMdataObType       LDMDTA.&Value({LDMdataObjectAttributes}{@ldmdotRef})
--    }
--
-- LDMdataObjectAttributes LDMDTA::={ldmdta1, ...}
--
-- ldmdta1    LDMDTA::={&ref c-ref0, &Value Type0}


-- Result code
ResultCode::=INTEGER{
   success                 (0), -- For authorization interpreted as PERMIT
   failure                 (1), -- For authorization interpreted as DENY
   invalidApp              (2),
   unknownApp              (3),
   invalidType             (4),
   invalidPriority         (5),
   invalidFilter           (6),
   invalidOrder            (7),
   areaFailure             (8),
   unknownType             (9),
   noAuthorization         (10),
   invalidTime             (11),
   unspecifiedError       (255)
   } (0..255)

-- Subscription ID
SubscriptionID::=Int2


-- LDM data
LDMinterfaceRecordRead::=SEQUENCE{
   recordID  LDMrecordID, -- LDM record ID
   geoRefs   LDMgeoRefs, -- Location Validity / reference
   timeRefs  LDMtimeRefs, -- Time Validity / reference
   genTime   TimeOfGeneration, -- time of generation
   data      LDMdataObject -- type and data
   }

LDMgeoRefs::=SEQUENCE{
   internal  LDMarea, -- LDM internal format
   original  LDMarea, -- Original format presented at time of writing
   requested LDMarea -- Format requested
   }

LDMtimeRefs::=SEQUENCE{
   internal  ValidityTimeInterval, -- LDM internal format
   original  ValidityTimeInterval, -- Original format presented at time of writing
   requested ValidityTimeInterval -- Format requested
   }


LDMinterfaceRecords::=SEQUENCE OF LDMinterfaceRecordRead


-- end of Interface parameters


-- interface functions

-- Registration / deregistration / revocation

LDMregisterRequest::=SEQUENCE{
   itssAppProcess  ApplicationID,
   ldmID           LDMid,
   priority        UserPriority,
   permissions     LDMpermissionList,
   secCredentials  LDMsecurityCredential
```

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```
   }

LDMregisterConfirm::=SEQUENCE{
   itssAppProcess  ApplicationID,
   ldmID           LDMid, -- set to the value of the LDM that confirms
   permissions     LDMpermissionList,
   result          ResultCode
   }


LDMderegisterRequest::=SEQUENCE{
   itssAppProcess  ApplicationID,
   ldmID           LDMid
   }


LDMderegisterConfirm::=SEQUENCE{
   itssAppProcess  ApplicationID,
   ldmID           LDMid, -- set to the value of the LDM that confirms
   result          ResultCode
   }


LDMrevokeAppNotifyRequest::=SEQUENCE{
   itssAppProcess  ApplicationID,
   ldmID           LDMid,
   priority        UserPriority, -- maximum still applicable or zero
   permissions     LDMpermission, -- still applicable (may be empty)
   reason          RevocationReason
   }

RevocationReason::=INTEGER{
   registrationRevokedByRegistrationAuthority  (0),
   registrationPeriodExpired                   (1),
   unspecifiedReason                           (255)
   } (0..255)

LDMrevokeAppNotifyConfirm::=SEQUENCE{
   itssAppProcess  ApplicationID,
   ldmID           LDMid,
   result          ResultCode
   }


-- Data providers

LDMaddRequest::=SEQUENCE{
   itssAppProcess  ApplicationID,
   ldmID           LDMid,
   data            LDMdataObject, -- type and data
   geoRef          LDMarea, -- Location Validity / reference
   timeRef         ValidityTimeInterval, -- Time Validity / reference
   genTime         TimeInformation, -- time of generation
   timeMandDelete  TimeInformation -- if time provided, then privacy flag = true
   }


LDMaddConfirm::=SEQUENCE{
   itssAppProcess  ApplicationID,
   ldmID           LDMid,
   ldmRecordID     LDMrecordID,
   result          ResultCode
   }


LDMupdateRequest::=SEQUENCE{
   itssAppProcess     ApplicationID,
   ldmID              LDMid,
   ldmRecordID        LDMrecordID,
   data               LDMdataObject, -- type and data
   geoRef             LDMarea, -- Location Validity / reference
```

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```
   timeRef            ValidityTimeInterval, -- Time Validity / reference
   genTime            TimeInformation, -- time of generation
   timeDelete         TimeInformation -- if time provided, then privacy flag = true
   }


LDMupdateConfirm::=SEQUENCE{
   itssAppProcess  ApplicationID,
   ldmID           LDMid,
   ldmRecordID     LDMrecordID,
   result          ResultCode
   }


LDMdeleteRequest::=SEQUENCE{
   itssAppProcess  ApplicationID,
   ldmID           LDMid,
   ldmRecordID     LDMrecordID
   }


LDMdeleteConfirm::=SEQUENCE{
   itssAppProcess  ApplicationID,
   ldmID           LDMid,
   ldmRecordID     LDMrecordID,
   result          ResultCode
   }

-- Data users

LDMsubscribeRequest::=SEQUENCE{
   itssAppProcess  ApplicationID,
   ldmID           LDMid,
   priority        UserPriority,
   ldmRecordID     LDMrecordID,
   ldmDoTypeID     LDMdataObjectTypeID,
   areaInterest    AreaOfInterest,
   timeInterest    TimeOfInterest,
   ageInterest     AgeOfInterest,
   filter          FilterSecondLevel,
   notifyInterval  NotificationInterval,
   notifyUpdate    NotificationUponUpdate
   }

-- Flag for notification upon update
NotificationUponUpdate::=Flag


LDMsubscribeConfirm::=SEQUENCE{
   itssAppProcess  ApplicationID,
   ldmID           LDMid,
   subscribeID     SubscriptionID,
   result          ResultCode
   }


LDMunsubscribeRequest::=SEQUENCE{
   itssAppProcess  ApplicationID,
   ldmID           LDMid,
   priority        UserPriority,
   subscribeID     SubscriptionID
   }


LDMunsubscribeConfirm::=SEQUENCE{
   itssAppProcess  ApplicationID,
   ldmID           LDMid,
   subscribeID     SubscriptionID,
   result          ResultCode
   }
```

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```
LDMqueryRequest::=SEQUENCE{
   itssAppProcess  ApplicationID,
   ldmID           LDMid,
   priority        UserPriority,
   ldmRecordID     LDMrecordID,
   ldmDoTypeID     LDMdataObjectTypeID,
   areaInterest    AreaOfInterest,
   timeInterest    TimeOfInterest,
   ageInterest     AgeOfInterest,
   filter          FilterSecondLevel
   }


LDMqueryConfirm::=SEQUENCE{
   itssAppProcess  ApplicationID,
   ldmID           LDMid,
   ldmData         LDMinterfaceRecords,
   result          ResultCode
   }


LDMnotifyRequest::=SEQUENCE{
   itssAppProcess  ApplicationID,
   ldmID           LDMid,
   subscribeID     SubscriptionID,
   ldmData         LDMinterfaceRecords
   }

-- Security entity

LDMcheckAuthorizationRequest::=SEQUENCE{
   itssAppProcess  ApplicationID,
   ldmID           LDMid,
   priority        UserPriority,
   permissions     LDMpermissionList,
   secCredentials  LDMsecurityCredential
   }


LDMcheckAuthorizationConfirm::=SEQUENCE{
   itssAppProcess  ApplicationID,
   ldmID           LDMid,
   priorityConf    UserPriority,
   permissionsConf LDMpermissionList,
   result          ResultCode
   }


LDMrevokeAuthorizationRequest::=SEQUENCE{
   itssAppProcess      ApplicationID,
   ldmID               LDMid,
   priorityRemain      UserPriority,
   permissionsRemain   LDMpermissionList
   }


LDMrevokeAuthorizationConfirm::=SEQUENCE{
   itssAppProcess   ApplicationID,
   ldmID            LDMid,
   result           ResultCode
   }


-- Management entity

-- Register LDM at management

LDMregisterManagementRequest::=SEQUENCE{
   ldmID               LDMid, -- assigned at time of implementation of LDM
   ldmDTs              ListOfLDMDTids,
```

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```
   ldmCapabilities      LDMcapabilities
   }

ListOfLDMDTids::=SEQUENCE OF LDMdataObjectTypeID

LDMcapabilities::=INTEGER{
   basic                    (0),
   electronicHorizon        (1),
   secondLevelFiltering     (2)
   } (0..255) -- used as a bit field indicating up to eight features

LDMregisterManagementConfirm::=SEQUENCE{
   ldmID               LDMid,
   result              ResultCode
   }

-- end of interface functions


-- FA-SAP service primitive functions
-- FASAPDOWN
c-ldmRegisterFA                RefFASAPDOWN::= c-ldmRegister
c-ldmDeregisterFA              RefFASAPDOWN::= c-ldmDeregister
c-ldmAddFA                     RefFASAPDOWN::= c-ldmAdd
c-ldmUpdateFA                  RefFASAPDOWN::= c-ldmUpdate
c-ldmDeleteFA                  RefFASAPDOWN::= c-ldmDelete
c-ldmSubscribeFA               RefFASAPDOWN::= c-ldmSubscribe
c-ldmUnsubscribeFA             RefFASAPDOWN::= c-ldmUnsubscribe
c-ldmQueryFA                   RefFASAPDOWN::= c-ldmQuery
c-ldmRevokeAppNotifyConfFA     RefFASAPDOWN::=c-ldmRevokeAppNotifyConf
c-ldmNotifyConfFA              RefFASAPDOWN::=c-ldmNotifyConf
c-ldmRegisterManagementConfFA  RefFASAPDOWN::=c-ldmRegisterManagementConf

ldmRegisterFA FASAPDOWN::={&primitiveRef 100, &Primitive LDMregisterRequest}
ldmDeregisterFA FASAPDOWN::={&primitiveRef 101, &Primitive LDMderegisterRequest}
ldmAddFA FASAPDOWN::={&primitiveRef 102, &Primitive LDMaddRequest}
ldmUpdateFA FASAPDOWN::={&primitiveRef 103, &Primitive LDMupdateRequest}
ldmDeleteFA FASAPDOWN::={&primitiveRef 104, &Primitive LDMdeleteRequest}
ldmSubscribeFA FASAPDOWN::={&primitiveRef 105, &Primitive LDMsubscribeRequest}
ldmUnsubscribeFA FASAPDOWN::={&primitiveRef 106, &Primitive LDMunsubscribeRequest}
ldmQueryFA FASAPDOWN::={&primitiveRef 107, &Primitive LDMqueryRequest}
ldmRevokeAppNotifyConfFA FASAPDOWN::={&primitiveRef 108, &Primitive NullType}
ldmNotifyConfFA FASAPDOWN::={&primitiveRef 109, &Primitive NullType}
ldmRegisterManagementConfFA FASAPDOWN:: = {&primitiveRef 110, &Primitive
LDMregisterManagementConfirm}

-- FASAPUP
c-ldmRegisterConfFA            RefFASAPUP::=c-ldmRegisterConf
c-ldmDeregisterConfFA          RefFASAPUP::=c-ldmDeregisterConf
c-ldmAddConfFA                 RefFASAPUP::=c-ldmAddConf
c-ldmUpdateConfFA              RefFASAPUP::=c-ldmUpdateConf
c-ldmDeleteConfFA              RefFASAPUP::=c-ldmDeleteConf
c-ldmSubscribeConfFA           RefFASAPUP::=c-ldmSubscribeConf
c-ldmUnsubscribeConfFA         RefFASAPUP::=c-ldmUnsubscribeConf
c-ldmQueryConfFA               RefFASAPUP::=c-ldmQueryConf
c-ldmRevokeAppNotifyFA         RefFASAPUP::=c-ldmRevokeAppNotify
c-ldmNotifyFA                  RefFASAPUP::=c-ldmNotify
c-ldmRegisterManagementFA      RefFASAPUP::=c-ldmRegisterManagement

ldmRegisterConfFA FASAPUP::={&primitiveRef 100, &Primitive LDMregisterConfirm}
ldmDeregisterConfFA FASAPUP::={&primitiveRef 101, &Primitive LDMderegisterConfirm}
ldmAddConfFA FASAPUP::={&primitiveRef 102, &Primitive LDMaddConfirm}
ldmUpdateConfFA FASAPUP::={&primitiveRef 103, &Primitive LDMupdateConfirm}
ldmDeleteConfFA FASAPUP::={&primitiveRef 104, &Primitive LDMdeleteConfirm}
ldmSubscribeConfFA FASAPUP::={&primitiveRef 105, &Primitive LDMsubscribeConfirm}
ldmUnsubscribeConfFA FASAPUP::={&primitiveRef 106, &Primitive LDMunsubscribeConfirm}
ldmQueryConfFA FASAPUP::={&primitiveRef 107, &Primitive LDMqueryConfirm}
ldmRevokeAppNotifyFA FASAPUP::={&primitiveRef 108, &Primitive LDMrevokeAppNotifyRequest}
ldmNotifyFA FASAPUP::={&primitiveRef 109, &Primitive LDMnotifyRequest}
ldmRegisterManagementFA FASAPUP:: = {&primitiveRef 110, &Primitive
LDMregisterManagementRequest}
```

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```
-- MF-SAP service primitive functions
-- MF-COMMAND.request
c-ldmRegister       RefMFSAP-CR::=100
c-ldmDeregister     RefMFSAP-CR::=101
c-ldmAdd            RefMFSAP-CR::=102
c-ldmUpdate         RefMFSAP-CR::=103
c-ldmDelete         RefMFSAP-CR::=104
c-ldmSubscribe      RefMFSAP-CR::=105
c-ldmUnsubscribe    RefMFSAP-CR::=106
c-ldmQuery          RefMFSAP-CR::=107

ldmRegister MFSAP-CR::={&mxref c-ldmRegister, &MXParam LDMregisterRequest}
ldmDeregister MFSAP-CR::={&mxref c-ldmDeregister, &MXParam LDMderegisterRequest}
ldmAdd MFSAP-CR::={&mxref c-ldmAdd, &MXParam LDMaddRequest}
ldmUpdate MFSAP-CR::={&mxref c-ldmUpdate, &MXParam LDMupdateRequest}
ldmDelete MFSAP-CR::={&mxref c-ldmDelete, &MXParam LDMdeleteRequest}
ldmSubscribe MFSAP-CR::={&mxref c-ldmSubscribe, &MXParam LDMsubscribeRequest}
ldmUnsubscribe MFSAP-CR::={&mxref c-ldmUnsubscribe, &MXParam LDMunsubscribeRequest}
ldmQuery MFSAP-CR::={&mxref c-ldmQuery, &MXParam LDMqueryRequest}

-- MF-COMMAND.confirm
c-ldmRegisterConf       RefMFSAP-CC::=c-ldmRegister
c-ldmDeregisterConf     RefMFSAP-CC::=c-ldmDeregister
c-ldmAddConf            RefMFSAP-CC::=c-ldmAdd
c-ldmUpdateConf         RefMFSAP-CC::=c-ldmUpdate
c-ldmDeleteConf         RefMFSAP-CC::=c-ldmDelete
c-ldmSubscribeConf      RefMFSAP-CC::=c-ldmSubscribe
c-ldmUnsubscribeConf    RefMFSAP-CC::=c-ldmUnsubscribe
c-ldmQueryConf          RefMFSAP-CC::=c-ldmQuery

ldmRegisterConf MFSAP-CC::={&mxref c-ldmRegisterConf, &MXParam LDMregisterConfirm}
ldmDeregisterConf MFSAP-CC::={&mxref c-ldmDeregisterConf, &MXParam LDMderegisterConfirm}
ldmAddConf MFSAP-CC::={&mxref c-ldmAddConf, &MXParam LDMaddConfirm}
ldmUpdateConf MFSAP-CC::={&mxref c-ldmUpdateConf, &MXParam LDMupdateConfirm}
ldmDeleteConf MFSAP-CC::={&mxref c-ldmDeleteConf, &MXParam LDMdeleteConfirm}
ldmSubscribeConf MFSAP-CC::={&mxref c-ldmSubscribeConf, &MXParam LDMsubscribeConfirm}
ldmUnsubscribeConf MFSAP-CC::={&mxref c-ldmUnsubscribeConf, &MXParam LDMunsubscribeConfirm}
ldmQueryConf MFSAP-CC::={&mxref c-ldmQueryConf, &MXParam LDMqueryConfirm}

-- MF-REQUEST.request
c-ldmRevokeAppNotify      RefMFSAP-RR::=108
c-ldmNotify               RefMFSAP-RR::=109
c-ldmRegisterManagement   RefMFSAP-RR::=110

ldmRevokeAppNotify MFSAP-RR::={&mxref c-ldmRevokeAppNotify, &MXParam
LDMrevokeAppNotifyRequest}
ldmNotify MFSAP-RR::={&mxref c-ldmNotify, &MXParam LDMnotifyRequest}
ldmRegisterManagement MFSAP-RR:: = {&mxref c-ldmRegisterManagement, &MXParam
LDMregisterManagementRequest}


-- MF-REQUEST.confirm
c-ldmRevokeAppNotifyConf      RefMFSAP-RC::= c-ldmRevokeAppNotify
c-ldmNotifyConf               RefMFSAP-RC::= c-ldmNotify
c-ldmRegisterManagementConf   RefMFSAP-RC::= c-ldmRegisterManagement

ldmRevokeAppNotifyConf MFSAP-RC::={&mxref c-ldmRevokeAppNotifyConf, &MXParam NullType} -
not used
ldmNotifyConf MFSAP-RC::={&mxref c-ldmNotifyConf, &MXParam NullType} - not used
ldmRegisterManagementConf MFSAP-RC:: = {&mxref c-ldmRegisterManagementConf, &MXParam
LDMregisterManagementConfirm} - not used


-- SF-SAP service primitive functions
-- SF-COMMAND.request
c-ldmRevoceAuthorization      RefSFSAP-CR::=100

ldmRevokeAuthorization SFSAP-CR::={&mxref c-ldmRevoceAuthorization, &MXParam
LDMrevokeAuthorizationRequest}
```

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```
-- SF-COMMAND.confirm
c-ldmRevoceAuthorizationConf  RefSFSAP-CC::= c-ldmRevoceAuthorization

ldmRevokeAuthorizationConf SFSAP-CC::={&mxref c-ldmRevoceAuthorizationConf, &MXParam
LDMrevokeAuthorizationConfirm}

-- SF-REQUEST.request
c-ldmCheckAuthorization       RefSFSAP-RR::=100

ldmCheckAuthorization SFSAP-RR::={&mxref c-ldmCheckAuthorization, &MXParam
LDMcheckAuthorizationRequest}

-- SF-REQUEST.confirm
c-ldmCheckAuthorizationConf   RefSFSAP-RC::= c-ldmCheckAuthorization

ldmCheckAuthorizationConf SFSAP-RC::={&mxref c-ldmCheckAuthorizationConf, &MXParam
LDMcheckAuthorizationConfirm}



-- General area definition
-- Geo-coordinate systems
GEOCOORD::=CLASS {
   &ref Ref-GeoCoordLDM,
   &Value
   }

Ref-GeoCoordLDM::=INTEGER{
   c-GeoCoord-Null         (0),
   c-GeoCoord-Polygon      (1)
} (0..255)

LocationValidity::=LDMarea

LDMarea::=SEQUENCE{
   geoRef     GEOCOORD.&ref({GeoCoordinates}),
   geoCoordinates   GEOCOORD.&Value({GeoCoordinates}{@geoRef})
  }

GeoCoordinates GEOCOORD::={geoCoordPolygon, ...}

geoCoordNull  GEOCOORD::={&ref c-GeoCoord-Null, &Value NullType}
geoCoordPolygon      GEOCOORD::={&ref c-GeoCoord-Polygon, &Value GeoPolygonArea}



-- General time system specification
TIMEINFO::=CLASS {
   &ref Ref-TimeInfoLDM,
   &Value
   }

Ref-TimeInfoLDM::=INTEGER{
   c-LDM-noTimeInfo        (0),
   c-LDM-Time48IAT         (1),
   c-LDM-doubleTime48IAT   (2)
} (0..255)

TimeInformation::=SEQUENCE{
   timeRef    TIMEINFO.&ref({TimeInfos}),
   timeInfo   TIMEINFO.&Value({TimeInfos}{@timeRef})
   }

TimeInfos TIMEINFO::={noTimeInfo | time48IAT | doubleTime48IAT, ...}

noTimeInfo    TIMEINFO::={&ref c-LDM-noTimeInfo, &Value NullType}
time48IAT         TIMEINFO::={&ref c-LDM-Time48IAT, &Value Time48IAT}
doubleTime48IAT   TIMEINFO::={&ref c-LDM-doubleTime48IAT, &Value DoubleTime48IAT}
```

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```
DoubleTime48IAT::=SEQUENCE{
   firstTime  Time48IAT, -- e.g. start of time interval
   secondTime Time48IAT -- e.g. stop of time interval
   }

-- Time of Generation
TimeOfGeneration::= TimeInformation

-- Time relative to time of generation
AgeOfInterest::=SEQUENCE{
   operator        Operators, -- e.g. <time of birth> "lt" timeReference
   timeReference   TimeInformation
   }

-- Time of interest (select either no info or a single info)
TimeOfInterest::=TimeInformation

-- Validity time interval(s)
ValidityTimeInterval::=SEQUENCE (SIZE(0..255)) OF TimeInformation - start/stop types only


-- Time definitions based on International Atomic Time
TimeOfCreation::= SEQUENCE{
   timeAdd          Time48IAT,
   timeLastUpdate   Time48IAT
   }


TimeOfMandatoryDeletion::= TimeInformation

TimeOfDeletion::=Time48IAT


-- Time interval between subsequent notifications
NotificationInterval::=Int2 -- time span in milliseconds



-- Filter mechanism
Operators::=INTEGER{
     equal       (0),
     notequal    (1),
     gt          (2),
     lt          (3),
     gte         (4),
     lte         (5),
     like        (6),
     notlike     (7)
     } (0..255) -- End of Operators

FilterSecondLevel::=ANDsequence

ANDsequence::=SEQUENCE OF ORsequence

ORsequence::= SEQUENCE OF FilterPrimitive

FilterPrimitive::=SEQUENCE{
   ldmAttributeID   LDMattributeID,
   operator  Operators,
   refValue  OCTET STRING -- to be converted into format given by ldmAttributeID
   }

LDMattributeID::=INTEGER

-- Utility types definitions


Int1::=INTEGER(0..255)
Int2::=INTEGER(0..65535)
Int4::=INTEGER(0..4294967295)
```

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```
Flag::=INTEGER{
   false  (0),
   true   (255)
   } (0..255)

PrivacyFlag::=Flag

-- LDM identifier
LDMid::=INTEGER{
   c-ldmidUnknown   (0),
   c-ldmidDefault   (255)
} (0..255)



-- Values
version Int1::=1 - version of this ASN.1 module

END
```

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# Annex B
(normative)

# LDM Data Dictionary

The LDM-DD, as all data dictionaries, is uniquely identified by a Data Dictionary Identifier (DataDictionaryID) of ASN.1 type `DataDictionaryID` specified in Annex A. The reference ID of the LDM-DD is DataDictionaryID = 1. The approach to present data in data dictionaries is not uniquely specified but dedicated to a specific data dictionary; see also References [1] and [23].

EXAMPLE Examples of data dictionaries are from SAE, ETSI, CEN/ISO, DATEX, JPEG, RDS-TMC.

This Technical Specification specifies the approach how data are presented in an LDM-DD. A two-dimensional addressing space as illustrated in Figure B.1 shall be used with the two dimensions:

a) LDM Data object Typ (LDM-DT) identifier;

b) LDM Data Attribute Type (LDM-DAT) identifier.

Content identified by this two-dimensional address space is outside the scope of this Technical Specification. The LDM-DD beneficially is maintained by means of a globally accessible registry.

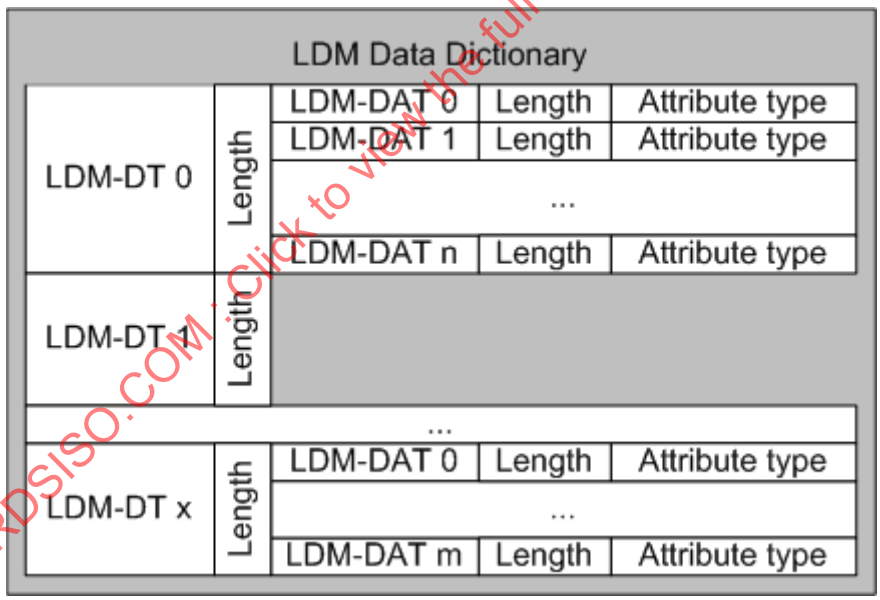


**Figure B.1 — LDM Data Dictionary concept**

This approach allows

— to subsequently create a global LDM-DD according to market needs,

— to use sub-sets of this global LDM-DD or the whole LDM-DD in implementations,

— to consider existing data dictionaries by performing an appropriate transformation into the elements of the global LDM-DD,

— to use existing sources of information (DATEX, JPEG, RDS-TMC, etc.) without the need to change anything in these legacy specifications,

— to use C-ITS-specific sources of information (CEN/ISO, ETSI, SAE), and

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— to define so far not existent information in the global LDM-DO format.

Transformation of legacy formats into the global LDM-DO format beneficially is performed by the message parsers having the knowledge of the legacy formats and the LDM-DO format.

Every LDM Data object Type (LDM-DT) shall be uniquely identified by an LDM-DT Identifier (LDM-DTID) of ASN.1 type `LDMdataObjectTypeID` specified in Annex A.

An LDM-DO shall be presented with the ASN.1 type `LDMdataObject` specified in Annex A (type-length-value encoded). It shall consist of sequence of zero or more LDM Data Attribute Types (LDM-DAT).

Every LDM-DAT shall be uniquely identified by an LDM-DAT identifier (LDM-DATID) of ASN.1 type `LDMattributeID` specified in Annex A.

A generic approach to specify the attributes of an LDM-DO is given by the ASN.1 type `LDMgenericDataObject`. This informative ASN.1 code can be used to create LDM-DOs.

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