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Facilities layer protocols and communication requirements for infrastructure services

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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Intelligent Transport Systems (ITS).

The present document includes the integration of infrastructure based application protocols within the ITS message environment.

Modal verbs terminology

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Introduction

The infrastructure services are application support facilities provided by the Facilities layer that construct, manage and process messages distributed from infrastructure to end-users or vice-versa based on payload received from the application. The infrastructure services specified in the present document support infrastructure-based applications in order to achieve communication interoperability, and may be implemented in parallel to other services in an ITS-S.

1 Scope

The present document provides specifications of infrastructure related ITS services to support communication between infrastructure ITS equipment and traffic participants using ITS equipment (e.g. vehicles, pedestrians). It defines services in the Facilities layer for communication between the infrastructure and traffic participants. The specifications cover the protocol handling for infrastructure-related messages as well as requirements to lower layer protocols and to the security entity.

2 References

2.1 Normative references

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

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

[1] ETSI EN 302 665 (V1.1.1): "Intelligent Transport Systems (ITS); Communications Architecture".

[2] ETSI TS 102 894-2 (V1.3.1): "Intelligent Transport Systems (ITS); Users and applications requirements; Part 2: Applications and facilities layer common data dictionary".

[3] ETSI EN 302 636-4-1 (V1.3.1): "Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 4: Geographical addressing and forwarding for point-to-point and point-to-multipoint communications; Sub-part 1: Media-Independent Functionality".

[4] ETSI EN 302 636-5-1 (V2.1.1): "Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 5: Transport Protocols; Sub-part 1: Basic Transport Protocol".

[5] Void.

[6] ETSI TS 103 097 (V1.3.1): "Intelligent Transport Systems (ITS); Security; Security header and certificate formats".

[7] CEN ISO/TS 19321-2015: "Intelligent transport systems - Cooperative ITS - Dictionary of in-vehicle information (IVI) data structures".

[8] CEN ISO/TS 19091: "Intelligent transport systems - Cooperative ITS - Using V2I and I2V communications for applications related to signalized intersections".

[9] ETSI EN 302 931 (V1.1.1): "Intelligent Transport Systems (ITS); Vehicular Communications; Geographical Area Definition".

[10] ISO/TS 17427:2014: "Intelligent transport systems - Cooperative systems - Roles and responsibilities in the context of cooperative ITS based on architecture(s) for cooperative systems".

[11] Recommendation ITU-T X.691/ISO/IEC 8825-2 (1997-12): "Information technology - ASN.1 encoding rules: Specification of Packed Encoding Rules (PER)".

[12] ETSI EN 302 637-2: "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 2: Specification of Cooperative Awareness Basic Service".

[13] ETSI EN 302 637-3: "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 3: Specifications of Decentralized Environmental Notification Basic Service".

[14] ETSI TS 102 965: "Intelligent Transport Systems (ITS); Application Object Identifier (ITS-AID); Registration".

[15] ETSI TS 103 248 (V1.2.1): "Intelligent Transport Systems (ITS); GeoNetworking; Port Numbers for the Basic Transport Protocol (BTP)".

[16] ETSI EN 302 663: "Intelligent Transport Systems (ITS); Access layer specification for Intelligent Transport Systems operating in the 5 GHz frequency band".

[17] ETSI TS 136 300: "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description; Stage 2 (3GPP TS 36.300 version 14.2.0 Release 14)".

[18] ETSI TS 102 636-4-2: "Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 4: Geographical addressing and forwarding for point-to-point and point-to-multipoint communications; Sub-part 2: Media-dependent functionalities for ITS-G5".

2.2 Informative references

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

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

[i.1] ETSI TS 102 965 (V1.2.1): "Intelligent Transport Systems (ITS); Application Object Identifier (ITS-AID); Registration".

[i.2] ISO/TS 17423:2014: "Intelligent Transport Systems - Cooperative Systems - Application requirements for selection of communication profiles".

[i.3] ISO/TS 14823: "Traffic and travel information - Messages via media independent stationary dissemination systems - Graphic data dictionary for pre-trip and in-trip information dissemination systems".

[i.4] IEEE 802.11™-2012: "IEEE Standard for Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks-Specific requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications".

[i.5] ETSI TS 102 723-5 (V1.1.1): "Intelligent Transport Systems (ITS); OSI cross-layer topics; Part 5: Interface between management entity and facilities layer".

[i.6] IANA Service Name and Transport Protocol Port Number Registry (2016-04-07).

NOTE: Available at https://www.iana.org/assignments/service-names-port-numbers/service-names-port-numbers.txt.

[i.7] IETF RFC 791: "IETF Internet Protocol".

[i.8] IETF RFC 768: "IETF User Datagram Protocol".

[i.9] IETF RFC 793: "IETF Transmission Control Protocol".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

destination area: geographic area in which a message is disseminated

NOTE: The definition is compliant to ETSI EN 302 637-3 [13].

driver awareness zone: area in which the driver will be informed about upcoming situations

NOTE: The definition is compliant to CEN ISO/TS 19321 [7].

ITS-G5: access technology to be according to ETSI EN 302 663 [16]

long range: communication with coverage of more than 500 m (e.g. cellular systems)

LTE-V2X sidelink: access technology using V2X sidelink communication according to ETSI TS 136 300 [17]

MAPEM: road/lane topology and traffic maneuver message

NOTE: As defined in Annex B including the corresponding extensions defined in CEN ISO/TS 19091 [8].

minimum dissemination area: minimum area where an information is disseminated by an ITS-S based on application requirements

NOTE: The definition is compliant to CEN ISO/TS 19321 [7].

relevance zone: area where the information is applicable

NOTE: The definition is compliant to CEN ISO/TS 19321 [7].

short range: communication with coverage of approximately 500 m (e.g. WLAN)

3.2 Abbreviations

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

3GPP	3rd Generation Partnership Project
AC	Access Category
AC_BE	Access Category Best Effort
AC_BK	Access Category Background
AC_VI	Access Category Video
AC_VO	Access Category Voice
ADU	Application Data Unit
AID	Action IDentifier
ASN	Anstract Syntax Notation
BTP	Basic Transport Protocol
CA	Certification Authority
C-ITS	Cooperative ITS
C-ITS-S	Cooperative ITS-Station
DAZ	Driver Awareness Zone
DE	Data Element
DEN	Decentralized Environmental Notification
DENM	DEN Message
E-UTRA	Evolved UTRA
GBC	GeoBroadCast
GN	GeoNetworking
GNSS	Global Navigation Satellite System
GPC	GNSS Postioning Correction
GPCH	General Purpose Channel

IANA	Internet Assigned Numbers Authority
IP	Internet Protocol
ISM	Industrial, Scientific and Medical
ITIS	International Traveler Information Systems
ITS	Intelligent Transport System
ITS-AID	ITS-Application IDentifier
ITS-S	ITS Station
ITU-T	International Telecommunication Union - Telecommunication
IVI	Infrastructure to Vehicle Information
IVIM	Infrastructure to Vehicle Information Message
LTE	Long Term Evolution
LTE-V2X	LTE-Vehicle to Everything
MAPEM	MAP (topology) Extended Message
MDA	Minimum Dissemination Area
MF-SAP	Management Facilities layer SAP
MSB	Most Significant Bit
MTU	Maximum Transmit Unit
PDU	Protocol Data Unit
PER	Packet Encoding Rule
R-ITS-S	Roadside ITS Station
RLT	Road and Lane Topology
RTCM	Radio Technical Commission For Maritime Services
RTCMEM	RTCM Extended Message
RTK	Real Time Kinematic
RZ	Relevance Zone
SAP	Service Access Primitive
SCH	Service Channel
SFCH	Safety Chanel
SHB	Single Hop Broadcast
SPATEM	Signal Phase And Timing Extended Message
SREM	Signal Request Extended Message
SSEM	Signal request Status Extended Message
SSID	Service Set Identifier
SSP	Service Specific Permissions
TC ID	Traffic Class IDentityTCC Traffic Control Center
TC	Traffic Class
TCC	Traffic Control Centre
TCP	Transmission Control Protocol
TLC	Traffic Light Control
TLM	Traffic Light Maneuver
TS	Technical Specification
UDP	User Datagram Protocol
UTRA	Universal Terrestrial Radio Access
V2X	Vehicle-to-Everything
V-ITS-S	Vehicular and personal ITS Station
WLAN	Wireless Local Area Network

4 Infrastructure services introduction and general requirements

4.1 Naming convention

Within the scope of the present document, the term "message" refers to the Facilities layer PDU; the term "payload" refers to the applications layer ADU. The payload is generated by the application and provided to the corresponding service of the Facilities layer. The Facilities service merges the *ItsPduHeader* with the payload, in order to construct a message. The message is then delivered to the ITS Networking & Transport Layer with a set of communication parameters.

NOTE: In other standards referred by the present document, the term message, payload, data structure may have different meanings e.g. in CEN ISO/TS 19091 [8] and in CEN ISO/TS 19321 [7]. Therefore, the current convention is defined for clarification purpose.

4.2 Infrastructure services in the ITS communications architecture

The infrastructure services refer to Facilities layer entities that manage the generation, transmission and reception of infrastructure-related messages from the infrastructure (C-ITS-S or R-ITS-S) to V-ITS-S or vice-versa. Figure 1 illustrates a high level functional architecture of the infrastructure services within the ITS communication architecture, as specified in ETSI EN 302 665 [1]. The messages are Facilities layer PDUs that are exchanged among ITS-Ss. The payload is generated by ITS applications in the transmitting ITS-S or other connected ITS-S (e.g. a C-ITS-S). At the transmitting ITS-S, the transmission of a message is triggered by applications or by forwarding mechanisms. For this purpose, the applications may connect to other entities of the Facilities layer or to external entities, in order to collect relevant information for the generation of the payload. Once the message is generated, the services may repeat the transmission, until the applications requests the termination of the transmission, or trigger another request to generate updated messages. At the receiving ITS-S, the messages are processed by the services and the content of the message is delivered to applications or to other Facilities layer entity. In one typical application, the message is transmitted by an R-ITS-S and disseminated to V-ITS-S within a target destination area, in which the information included in the message is considered as relevant to traffic participants.

In the scope of the present document, the infrastructure services supports the management of the following message types. As result, the infrastructure services include a set of service entities as listed below:

- SPATEM as defined in Annex A. The corresponding service entity is referred as "Traffic Light Maneuver" - TLM service in the present document. TLM service is specified in clause 5 of the present document.
- MAPEM as defined in Annex B. The corresponding service entity is referred as "Road and Lane Topology" - RLT service in the present document. RLT service is specified in clause 6 of the present document.
- IVIM as defined in Annex C. The corresponding service entity is referred as "Infrastructure to Vehicle Information" - IVI service in the present document. IVI service is specified in clause 7 of the present document.
- SREM as specified in Annex D. The corresponding service entity is referred as "Traffic Light Control" - TLC service in the present document. TLC service is specified in clause 8 of the present document.
- SSEM as specified in Annex E. The corresponding service is referred as " Traffic Light Control" - TLC service in the present document. TLC service is specified in clause 8 of the present document.

NOTE: Other messages may be supported by infrastructure services in the future.

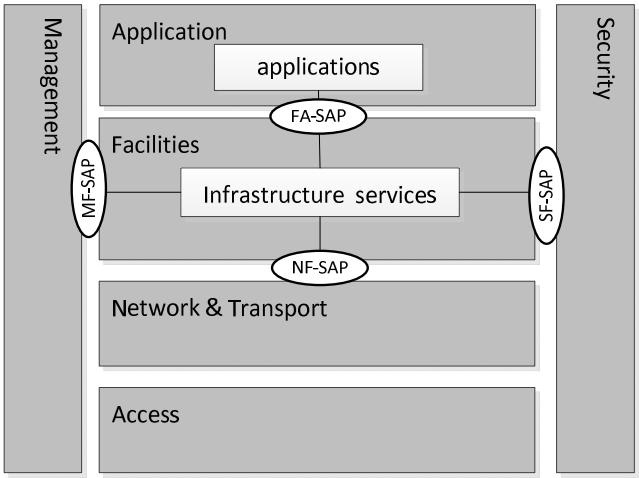

Figure 1: Infrastructure services within the ITS-S architecture

The infrastructure service shall provide at least the following functions.

For the transmission service:

- Message encoding.
- Transmission management.

For the reception service:

- Message decoding.
- Reception management.

4.3 Infrastructure services in the ITS organizational architecture

Within the role "System Operation" as defined in ISO/TS 17427 [10], the following sub roles are relevant for the infrastructure services:

- "Content Provision" is responsible for generating the information that is conveyed in the message. This task is included in any application providing information to the application which generates the payload.
- "Service Provision" is responsible for the generation of the payload and the transmission of the message using an ITS-S. This task is managed by the application making use of the infrastructure services.
- "Service Presentation" is responsible for the reception of the messages and its processing and presentation. This task is managed by the infrastructure services and the application.

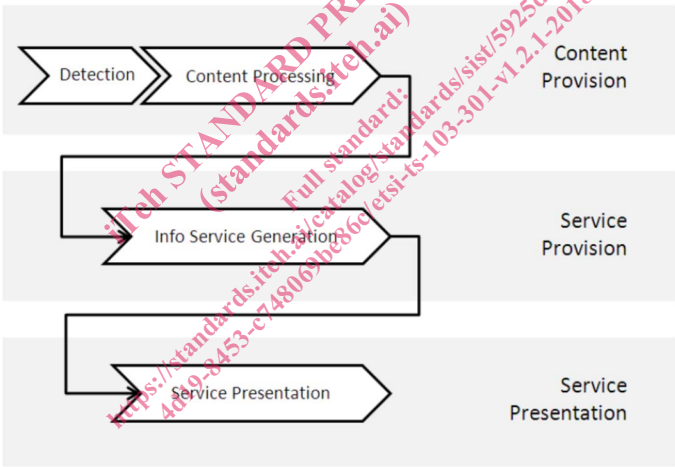

Figure 2: Identification of sub-roles of the role system (lifecycle) operation in the ITS organizational architecture

4.4 Interfaces of the infrastructure services

4.4.1 Interface between Application layer and Facilities layer

The infrastructure services within the Facilities layer provide APIs to applications for the processing of the payload at the transmitting ITS-S and the receiving ITS-S. An application may execute requests to the infrastructure services in the Facilities layer to trigger, update or terminate transmission of a message. In addition, a set of Facilities control information is passed as specified in Table 1.

Table 1 presents the Facilities control Information (SAP primitives) contained in an application request.

Table 1: Facilities control information (SAP primitives)

Category	Data	Definition
Data passed from application to infrastructure services	Infrastructure message identification	Identification of the message
	Request type	Trigger, update or ending of transmission
	Dissemination parameter	For more details see the dissemination profile for each service in the clauses 5 to 8
	Traffic class	GN traffic class as defined in ETSI EN 302 636-4-1 [3], if GeoNetworking/BTP is used
	Payload	Information contained in payload
Data returned from I2V service to the requesting application	actionID or other applicable identifier	The infrastructure service returns the message identification or other applicable identifier created by the infrastructure service to the requesting application
	Failure notification	The infrastructure service returns a failure notification to the requesting application

4.4.2 Interface between Facilities layer and Management entity

The infrastructure services may exchange information with the Management entity. This includes the default service communication parameters specified in clauses 5 to 8. The interface MF-SAP may be realized as the MF-SAP ETSI TS 102 723-5 [i.5].

4.4.3 Interface between Facilities layer and Security entity

The infrastructure service may exchange information with the Security entity.

4.4.4 Interface between Facilities layer and the N&T layer

The infrastructure services deliver the message as payload to the ITS Networking & Transport Layer for dissemination via the NF-SAP.

The ITS Networking & Transport Layer indicates the reception of an ITS message to the infrastructure services.

4.5 Common protocol requirements for infrastructure services

4.5.1 Security for messages used by infrastructure

The security mechanisms for messages used by the infrastructure service as specified in the present document shall use the message authentication with signatures to be verified at the receiving ITS-S with public keys contained in certificates. A certificate indicates its holder's permissions, i.e. what statements the holder is allowed to make or privileges it is allowed to assert in a message signed by that certificate. The format for the certificates shall be as specified in ETSI TS 103 097 [6].

Service permissions are indicated by a pair of identifiers within a certificate, the ITS-AID and the SSP. The ITS-Application Identifier (ITS-AID) as given in ETSI TS 102 965 [i.1] indicates the overall type of permissions being granted.

The Service Specific Permissions (SSP) is a field that indicates specific sets of permissions within the overall permissions indicated by the ITS-AID. The originating ITS-S shall provide SSP information in its certificate for all generated, signed messages. The SSP permissions are defined for each message in the corresponding clause. The common approach that is used for all messages is that the SSP information is constructed out of N octets with a maximum length as specified in ETSI TS 103 097 [6]. For each octet, the most significant bit (MSB) shall be the leftmost bit. The transmission order shall always be the MSB first. The first octet shall control the SSP version and be interpreted in the following way:

0: No version, length 1 octet; the value shall only be used for testing purposes.

1..n: SSP version as defined in the present document for each service (see "SSP version control").