



Technical Specification

**Intelligent Transport Systems (ITS);
Users and applications requirements;
Part 1: Facility layer structure, functional requirements
and specifications**

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Foreword

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

The present document is part 1 of a multi-part deliverable covering the ITS applications and facilities layer, as identified below:

Part 1: "Facility layer structure, functional requirements and specifications";

Part 2: "Applications and facilities layer common data dictionary".

The present document has been prepared by considering feedback from the Car-to-Car Communication Consortium (C2C-CC). The specifications of facilities layer structure and facilities layer entities are based on experience gathered from various European Projects such as DRIVE C2X, CVIS, SCORE@F and simTD.

Introduction

The present document provides architecture and functional specifications for the facilities layer of the ITS station (ITS-S) as defined in [1]. It is based on the previous work that has been realized within ETSI TC ITS WG1 related to the Basic Set of Applications (BSA) [i.1].

ITS applications are distributed among multiple ITS-Ss in order to share information using wireless communications. ITS applications provide a large diversity of customer's services. BSA has been defined by ETSI TC as a set of ITS applications that can be deployed reasonably within a three-year time frame after its standardization completion. Furthermore, ETSI TC ITS developed and defined functional requirements for BSA [i.2].

This previous work will allow ETSI TC ITS to identify a set of facilities in the facilities layer that are required to satisfy some common functional requirements and operational requirements of BSA. The facilities specified in the present document are minimum functionalities, services and data that are needed to ensure the interoperability and basic operation of ITS applications. The architecture of the facilities layer is intended to be an open architecture, which is available for ITS application developers to incorporate advanced proprietary facilities and different kinds of access networks such as ITS G5 or cellular networks.

The following projects and organizations had been consulted during the preparation of the present document:

- Car to Car Communication Consortium (<http://www.car-to-car.org>)
- COMeSafety (<http://www.comesafety.org>)
- PREDRIVE C2X (www.pre-drive-c2x.eu)
- DRIVE C2X (<http://www.drive-c2x.eu>)
- CVIS (www.cvisproject.org)
- simTD (www.simtd.de)

- CoVel (www.covel-project.eu)
- SCORE@F (<http://www.scoref.fr/>)

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1 Scope

The present document defines the functional architecture for the facilities layer of the ITS station as defined in [1] and provides functional requirements and specifications for main identified facilities.

The identified facilities are required to support BSA as defined in [i.1]. Other proprietary facilities might be required to be included in the facilities layer for BSA and other ITS applications. Such proprietary facilities are not defined in the present document.

2 References

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

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

2.1 Normative references

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

- [1] ETSI EN 302 665 (V1.1.1): "Intelligent Transport Systems (ITS); Communications Architecture".
- [2] ETSI EN 302 637-2: "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 2: Specification of Cooperative Awareness Basic Service".
- [3] ETSI EN 302 637-3: "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 3: Specifications of Decentralized Environmental Notification Basic Service".

2.2 Informative references

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

- [i.1] ETSI TR 102 638 (V1.1.1): "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Definitions".
- [i.2] ETSI TS 102 637-1 (V1.1.1): "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 1: Functional Requirements".
- [i.3] CEN/TS 16157-1: "Intelligent transport systems - DATEX II data exchange specifications for traffic management and information - Part 1: Context and framework".
- [i.4] ETSI TS 102 890-2: "Intelligent Transport Systems (ITS); Facilities layer function; Part 2: Services announcement specification".
- [i.5] ETSI TR 102 893 (V1.1.2): "Intelligent Transport Systems (ITS); Security; Threat, Vulnerability and Risk Analysis (TVRA)".
- [i.6] ETSI TS 103 084: Intelligent Transport Systems (ITS); Vehicular Communications; GeoMessaging Enabler".

- [i.7] ETSI EN 302 636-4-1: "Intelligent Transport System (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".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in [1] and the following apply:

application support: sub set of facilities, providing support elements for ITS applications

backend systems: system that includes middleware in the generic domain, providing back end support and functions for BSA ITS use case

basic set of applications: group of applications, supported by vehicular communication system

NOTE: BSA definition is provided in [i.1]

CA basic service: facility at the facilities layer to support ITS applications, CAM management and CAM dissemination

communication support: sub set of facilities, providing support for communications

cooperative awareness message: ITS facilities layer PDU providing ITS-S information

decentralized environmental notification message: ITS facilities layer PDU providing event information

DEN basic service: facility at the facilities layer to support ITS applications, DENM management and DENM dissemination

facility: functionalities, services or data provided by the facilities layer

information support: sub set of facilities, providing support for data management

ITS application: component of ITS applications layer

ITS use cases: procedure of executing an ITS application

LDM: local georeferenced database

message: facilities layer or application layer PDU

NOTE: Examples are cooperative awareness message and decentralized environmental notification message.

3.2 Abbreviations

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

AID	Application identifier
ALERT-C	Advice and problem Location for European Road Traffic
API	Application Programming Interface
ASN.1	Abstract Syntax Notation One
BSA	Basic Set of Application
C2C-CC	Car to Car Communication Consortium
CA	Cooperative Awareness
CAM	Cooperative Awareness Message
CF	Common Facility
DCC	Decentralized Congestion Control
DEN	Decentralized Environmental Notification
DENM	Decentralized Environmental Notification Message
DF	Domain Facility

DGPS	Differential Global Positioning System
DIASER	DIALOGue Standard for traffic Regulation Equipment
E2E	End to end
EFCD	Extended vehicle floating car data
EGNOS	European Geostationary Navigation Overlay Service
FA-SAP	Facilities Application SAP
GNSS	Global Navigation Satellite System
HMI	Human Machine Interface
HTTP	Hypertext Transfer Protocol
ISO	International Organization for Standardization
ITS	Intelligent Transport System
ITS-S	ITS station
IVS	In vehicle signage
LDM	Local Dynamic Map
MF-SAP	Management Facilities SAP
N&T	Networking and transport layer
NF-SAP	Networking and transport Facilities SAP
OSI	Open Systems Interconnection
PDU	Protocol Data Unit
PER	Packed Encoding Rules
QoS	Quality of Service
RSU	Road side unit
SAM	Service Announcement message
SAP	Service Access Point
SF-SAP	Security Facilities SAP
SOAP	Simple Object Access Protocol
SPAT	Signal Phase And Timing
TAI	International Atomic Time
TMC	Traffic Message Channel
TMC-LOC	TMC Location Referencing
TOPO	Road topology message
TPEG	Transport Protocol Experts Group
TPEG-LOC	TPEG Location Referencing
TVRA	Vulnerability and Risk Analysis
VMS	Variable Message Sign
XER	XML encoding rules
XML	Extensible Markup Language

4 ITS application overview

The overall ITS environment comprises ITS stations (ITS-S) that may communicate directly as follows:

- From Vehicle to Vehicle, via ad-hoc (or cellular) communication or based on Infrastructure involvement;
- From Vehicle to Infrastructure; and
- From Infrastructure to Vehicle.

ITS-Ss may communicate with each other through a local wireless access point (e.g. ITS G5 based) or a wireless wide area network (e.g. a cellular network).

This is shown in simplified form in figure 4.1. The dotted lines represent the logical connections between ITS-Ss.

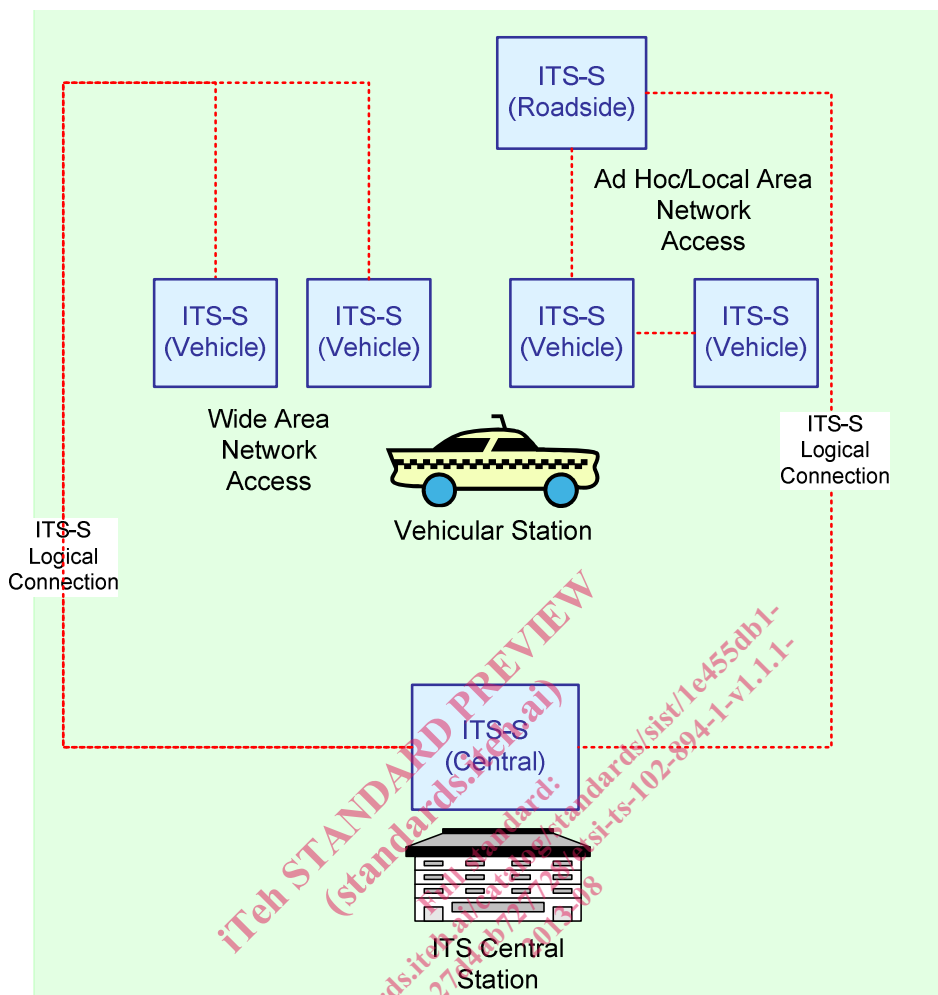


Figure 4.1: Simplified view of ITS environment

4.1 ITS architecture and ITS stations

Four ITS-S types are defined in [1], namely:

- **Central ITS-S:** A central ITS-S provides centralized ITS applications. A central ITS-S may play the role of traffic operator, road operator, services provider or content provider. Furthermore, a central ITS-S may require further connection with backend systems via e.g. Internet. For deployment and performances needs, specific instances of central ITS-S may contain grouping of Applications or Facilities.
- **Road side ITS-S:** A road side ITS-S provides ITS applications from the road side. A road side ITS-S may provide ITS applications independently or cooperatively with central ITS-S or other road side ITS-Ss. For deployment and performances needs, specific instances of road side ITS-S may contain grouping of Applications or Facilities.
- **Vehicle ITS-S:** A vehicle ITS-S provides ITS applications to vehicle drivers and/or passengers. It may require an interface for accessing in-vehicle data from the in-vehicle network or in vehicle system. For deployment and performances needs, specific instances of vehicle ITS-S may contain grouping of Applications or Facilities.
- **Personal ITS-S:** A personal ITS-S provides ITS applications to personal and nomadic devices. For deployment and performances needs, specific instances of personal ITS-S may contain grouping of Applications or Facilities.

A common reference communication architecture for all ITS stations is defined in [1] and as illustrated in figure 4.2. This architecture is an extension of the ISO 7-layer OSI model.

The present document defines the functional architecture of the facilities layer.

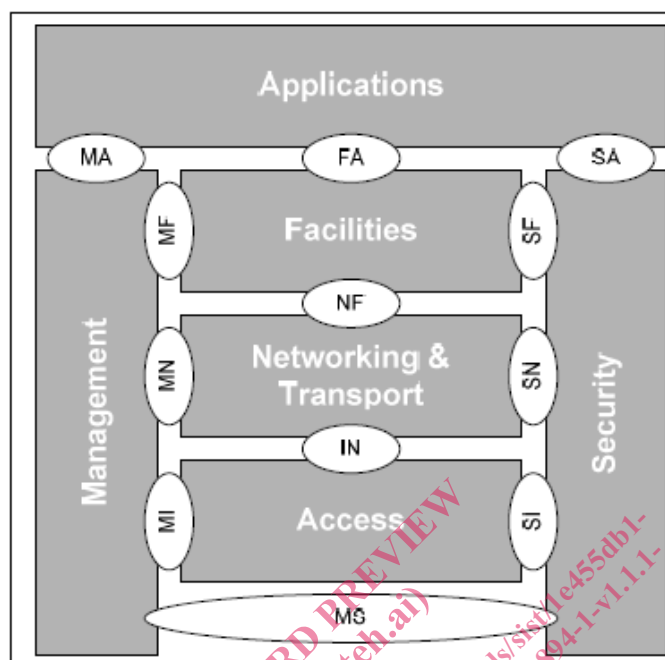


Figure 4.2: ITS station reference architecture

4.2 Application layer overview

ITS applications are defined within the application layer. An ITS application makes use of the underlying facilities and communication capacities provided by the ITS-S.

The applications layer provides ITS services. Three classes of applications have been defined in [i.1]: road safety, traffic efficiency and other applications. Each application can be assigned to one of the three identified application classes.

The Basic Set of Applications (BSA) are applications that are considered as deployable with reasonable efforts within 3 years' time scale after the complete standardization of the system. Each application regroups a set of use cases to realize some user benefits, including societal benefits, mobility benefits or customer benefits. The complete list of the BSA use cases and assigned applications are provided in [i.1].

The facilities layer is a middleware composed of multiple facilities. A facility is a component that provides functions, information or services to ITS applications. It exchanges data with lower layers and with management and security entities of the ITS-S as defined in [1].

The present document provides specifications of the facilities layer entities in support of the BSA. Further use cases are expected to be added in the future.

5 Facilities layer functional architecture

5.1 ITS-S external gateways

In order to connect with external systems, an ITS-S may provide gateway functions for these external systems to exchange information with the facilities layer of the ITS-S. For BSA, one or multiple gateway functions may need to be developed in order to satisfy the application requirements.

5.1.1 Vehicle ITS-S gateway to in vehicle network

For a vehicle ITS-S, the facilities layer is connected to the in-vehicle network via an in-vehicle data gateway as illustrated in figure 5.1. The facilities and applications of a vehicle ITS-S receive from this gateway the required in-vehicle data in order to construct messages (e.g. CAM and DENM) and for the application usage.

The implementation of the in vehicle data gateway needs to adapt to the specifications of the in vehicle network which may be proprietary to the industry. Therefore, the specifications of this gateway are out of the scope of the present document.

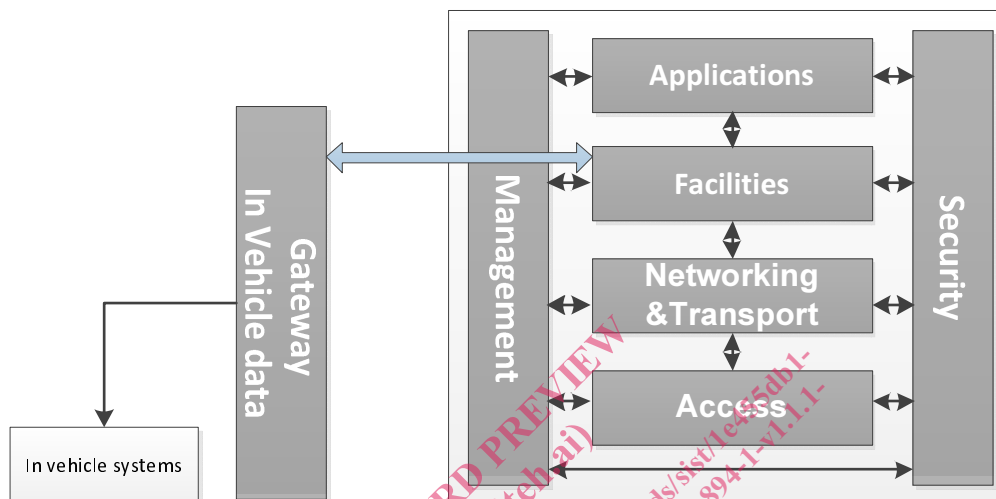


Figure 5.1: Vehicle ITS-S in-vehicle data gateway

5.1.2 Road side ITS-S gateway to central ITS-Ss

A roadside ITS-S is in general connected to a central ITS-S e.g. traffic management centre or road operator centre. In a possible road side ITS-S deployment scenario, road side ITS-Ss are managed by a private road infrastructure management network. Specific protocols for the traffic management, for the roadside equipment management and operational management are applied within such road infrastructure network. A gateway function may be equipped at the road side ITS-S in order to provide connections between message exchanges protocols (e.g. CAM, DENM) and these infrastructure protocols. In Europe, DATEX II protocol [i.3] is a standardized protocol deployed for exchanges of the traffic management information between traffic management centres and between traffic management centre and road side equipment (e.g. Variable Message Sign System). In a possible implementation, a roadside ITS-S is connected to road infrastructure network by a DATEX II gateway as illustrated in figure 5.2. A road side ITS-S may either receive information from central ITS-S or send information to central ITS-S via this gateway.

The DATEX II gateway of a road side ITS-S may include several functions:

- Aggregation of the received messages from vehicle ITS-Ss (such as CAM and DENM) and transmit to traffic management centre in DATEX II messages.
- Receive and filter traffic management information from traffic management center in DATEX II protocol, then transmit to vehicle ITS-S in messages such as CAM or DENM.

Detailed specifications of this gateway is out of the scope of the present document.

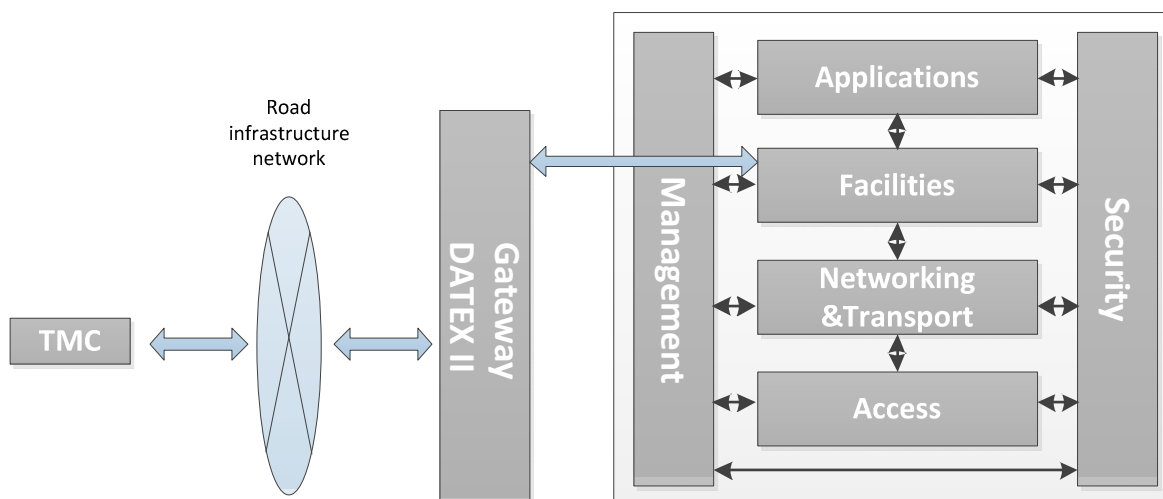


Figure 5.2: Roadside ITS-S gateway to road infrastructure network

5.1.3 Road side ITS-S or central ITS-S gateway to road equipment

An ITS applications may require data related to the traffic regulation (e.g. rail-road intersection, traffic light status, speed limit), or require support from the road side detection capacities (e.g. road side sensors). This requires that road side equipment exchanges information with central or roadside ITS-S. For example, as specified in [i.2] in the third part intersection collision risk warning, a road side ITS-S equipped at the intersection may detect the traffic light violation of a vehicle by dedicated road side sensors (e.g. intersection radar, camera), then this road side ITS-S triggers a DENM and disseminates to other oncoming vehicles in order to reduce the risk of intersection collision.

A central or roadside ITS-S may obtain traffic regulation and road side sensor data via a specific gateway to the road side equipment as presented in figure 5.3. National or international standards may already exist, e.g. DIASER a French standard for information exchanges between traffic light controllers and traffic light equipment. These standards are to be taken into account when developing this gateway interface, detailed specifications of this gateway is out of the scope of the present document.

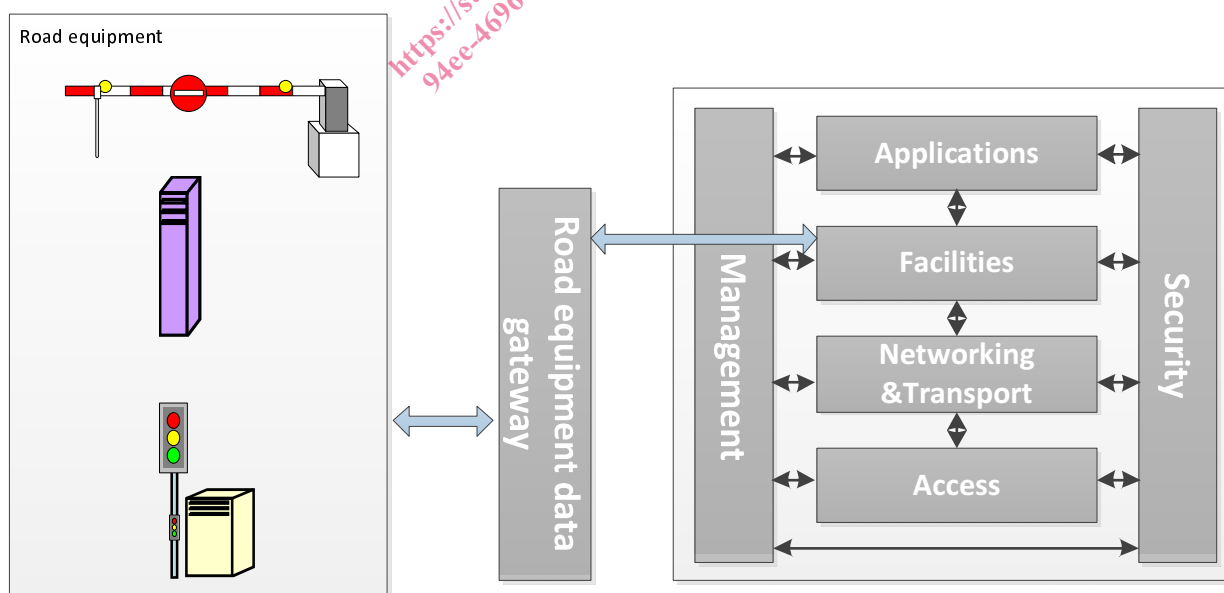


Figure 5.3: Roadside ITS-S gateway to road equipment