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Intelligent transport systems — Communications access for land mobiles (CALM) — Architecture

Systèmes intelligents de transport — Accès aux communications des services mobiles terrestres (CALM) — Architecture

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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ISO 21217 was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems*.

Introduction

This International Standard is part of a family of International Standards based on the communications access for land mobiles (CALM) concept. These International Standards specify a common architecture, network protocols and communication interface definitions for wired and wireless communications using various access technologies including cellular 2nd generation, cellular 3rd generation, satellite, infra-red, 5 GHz micro-wave, 60 GHz millimetre-wave and mobile wireless broadband. These and other access technologies that can be incorporated are designed to provide broadcast, unicast and multicast communications between mobile stations, between mobile and fixed stations and between fixed stations in the intelligent transport systems (ITS) sector.

This International Standard describes the common architectural framework around which CALM-compliant communication entities called ITS stations (ITS-Ss) are instantiated, and provides the architectural reference for use by the CALM family of International Standards, including the lower layer service access point specifications described in ISO 21218, network protocol specifications described in ISO 21210 (IPv6 networking) and ISO 29281 (non-IP networking), and the ITS-S management specifications described in ISO 24102.

The relationship between the members of the CALM family of International Standards is shown in Figure A.1. The numbers in the boxes are references to the International Standard in which the indicated functionality is specified.

The functional requirements for information transmission in the ITS sector over large distances using wireless access technologies may be very different from the requirements for, for example, European dedicated short range communication (DSRC). In ITS, large volumes of data are required for purposes such as safety, traffic information and management, video downloads to mobile stations for tourist information and entertainment and navigation-system-updates. In order to support such services, mobile stations need to be able to communicate over longer ranges with fixed stations, and the system must be able to hand over sessions from one fixed station to another. Thus, the CALM family of International Standards is explicitly designed to enable quasi-continuous communications, communications of protracted duration, and short messages and sessions of high priority with stringent time constraints.

CALM-complaint systems provide the ability to support handover of different types. One of the essential features of the CALM concept is the ability to support media independent handover (MIH), also referred to as heterogeneous handover, between the various access technologies supported by CALM, e.g. cellular, satellite, microwave, mobile wireless broadband, infra-red, DSRC. With this flexibility, CALM-complaint systems provide the ability to use the most appropriate access technology for message delivery. Selection rules that are supported include user preferences and access technology capabilities in deciding which access technology to use for a particular session, and when to handover between access technologies or between service providers on the same access technology. It is also important to note that communication between ITS-Ss is peer-to-peer, regardless of the networks providing the connectivity. This provides flexibility in designing applications for the ITS sector. While this flexibility is very important in providing quasi-continuous connectivity, applications may be restricted to specific access technologies and operational frequency bands, if required.

A fundamental advantage of the CALM concept over traditional systems is that applications are abstracted from the access technologies that provide the wireless connectivity and the networks that transport the information from the source to the destination(s). With reference to Figure A.1, this means that ITS-Ss are not limited to a single access technology and networking protocol, and can implement any of those supported; it also means that the ITS-S management can make optimal use of all these resources. To exploit this flexibility, CALM-complaint systems provide the ability to support handover of different types, including those involving a change of communication interface (which may or may not involve a change of access technology, since ITS-Ss may have multiple communication interfaces using the same access technology), those involving reconfiguration or change of the network employed to provide connectivity, and those involving both a change in communication interface and network reconfiguration.

The architecture specified within this International Standard makes provision for rapid session initialization, where this is required, e.g. for road safety applications.

The architecture specified within this International Standard supports a variety of different ITS-S implementations, ranging from “simple single-box implementations” up to “complex distributed implementations” where the complete ITS-S functionality is distributed in several physical boxes interconnected with wired or wireless local networks. The instantiation of access technologies used for these local station-internal networks follows the same principles as the instantiation of access technologies used to connect to external networks.

Intelligent transport systems — Communications access for land mobiles (CALM) — Architecture

1 Scope

This International Standard specifies the architectural communications framework of intelligent transport systems (ITS) for the family of CALM-related International Standards. The architecture is described in an abstract way with several graphical views and examples. The graphical representations partly follow the ISO Open Systems Interconnection (OSI) principles. In addition to the requirements specified within this International Standard, a number of notes and examples are provided to illustrate the CALM concept.

Wherever practicable, this International Standard has been developed by reference to suitable extant International Standards, adopted by selection. The architecture provides for regional variations where regulations differ in different countries and regions.

2 Conformance

Conformance declarations for the various parts of a CALM-compliant system shall be based on the relevant CALM-related International Standards.

3 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 21210, *Intelligent transport systems — Communications access for land mobiles (CALM) — IPv6 Networking*

ISO 21218, *Intelligent transport systems — Communications access for land mobiles (CALM) — Medium service access points*

ISO 24102, *Intelligent transport systems — Communications access for land mobiles (CALM) — Management*

4 Terms, definitions and abbreviated terms

4.1 Terms and definitions

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

4.1.1
access technology
technology employed in a communication interface to access a specific medium

4.1.2
CALM-aware application
ITS-S application which is capable of supporting features specific to CALM

NOTE CI selection management is an example.

4.1.3
central ITS-S
central ITS station
implementation of an ITS-S in a central ITS subsystem

4.1.4
FA interface
interface between the facilities layer and the ITS-S applications entity

NOTE The FA interface is presented in Figure 14.

4.1.5
geo-networking
geo-routing
network layer protocol using addresses in the form of geo-coordinates which identify target areas of possible destination stations

4.1.6
heterogeneous handover
process by which a communication link is switched from one virtual communication interface to another one of a different medium type

4.1.7
homogeneous handover
process by which a communication link is switched from one virtual communication interface to another one of the same medium type

4.1.8
IN interface
interface between the access layer and the networking and transport layer

NOTE The IN interface is presented in Figure 14.

4.1.9
ITS service
service provided by a set of ITS-S applications

4.1.10
ITS-S
ITS station
entity in a communication network, comprised of application, facilities, networking and access layer components specified in this International Standard that operate within a bounded secure management domain

4.1.11
ITS-S application
functionality in an ITS-S that uses ITS-S services to connect to one or more other ITS-S application

4.1.12
ITS-S gateway
gateway functionality provided in the facilities layer of an ITS-S

4.1.13
ITS-S host
application and facilities functionality provided in an ITS-S together with a minimum communication functionality to connect to the ITS-S internal network

4.1.14
ITS-S router
routing functionality provided in an ITS-S

4.1.15
ITS-S service
communication functionality offered by an ITS-S to an ITS-S application

4.1.16
MA interface
interface between the communication and station management entity and the ITS-S applications entity

NOTE The MA interface is presented in Figure 14.

4.1.17
medium
any entity upon which a signal is impressed or from which a signal is received, e.g. wireless or on a wire, radio waves or light, low or high frequency band, modulation scheme

4.1.18
MF interface
interface between the communication and station management entity and the facilities layer

NOTE The MF interface is presented in Figure 14.

4.1.19
MI interface
interface between the communication and station management entity and the access layer

NOTE The MI interface is presented in Figure 14.

4.1.20
MN interface
interface between the communication and station management entity and the networking and transport layer

NOTE The MN interface is presented in Figure 14.

4.1.21
MS interface
interface between the communication and station management entity and the security entity

NOTE The MS interface is presented in Figure 14.

4.1.22
network-based multi-hopping
multi-hopping from ITS-S to ITS-S performed by a networking protocol

4.1.23
NF interface
interface between the networking and transport layer and the facilities layer

NOTE The NF interface is presented in Figure 14.

4.1.24
personal ITS-S
personal ITS station
implementation of an ITS-S in a personal ITS subsystem

4.1.25
roadside ITS-S
roadside ITS station
implementation of an ITS-S in a roadside ITS subsystem

4.1.26
SA interface
interface between the security entity and the ITS-S applications entity

NOTE The SA interface is presented in Figure 14.

4.1.27
SF interface
interface between the security entity and the facilities layer

NOTE The SF interface is presented in Figure 14.

4.1.28
SI interface
interface between the security entity and the access layer

NOTE The SI interface is presented in Figure 14.

4.1.29
SN interface
interface between the security entity and the networking and transport layer

NOTE The SN interface is presented in Figure 14.

4.1.30
vehicle ITS-S
vehicle ITS station
implementation of an ITS-S in a vehicular ITS subsystem

4.2 Abbreviated terms

API	application programming interface
CAL	communication adaptation layer
CALM	communications access for land mobiles
CCK	CALM communications kernel
CI	communication interface
DSRC	dedicated short range communication
ECU	electronic control unit
HMI	human-machine interface
IPv6	Internet protocol version 6
ITS	intelligent transport systems
LLC	logical link control
PDA	personal digital assistant
SAP	service access point
VMS	vehicle motion sensor

5 Requirements

5.1 Principles for CALM-related International Standards

CALM-related International Standards shall focus on specifying open interfaces with regard to the functionalities required for all relevant layers of the OSI reference model.

CALM-related International Standards shall not specify implementation aspects, except in situations where such specification is deemed essential to interoperability of the interface protocol.

5.2 ITS viewpoint

5.2.1 Wireless links

Figure 1 illustrates the global ITS scope to be considered by the set of CALM-related International Standards. It shows several types of access technologies for wireless communication links between individual ITS-Ss and between ITS-Ss and legacy stations which can be expected to be present in ITS environments.

NOTE The CALM concept is not limited to the access technologies presented in Figure 1.

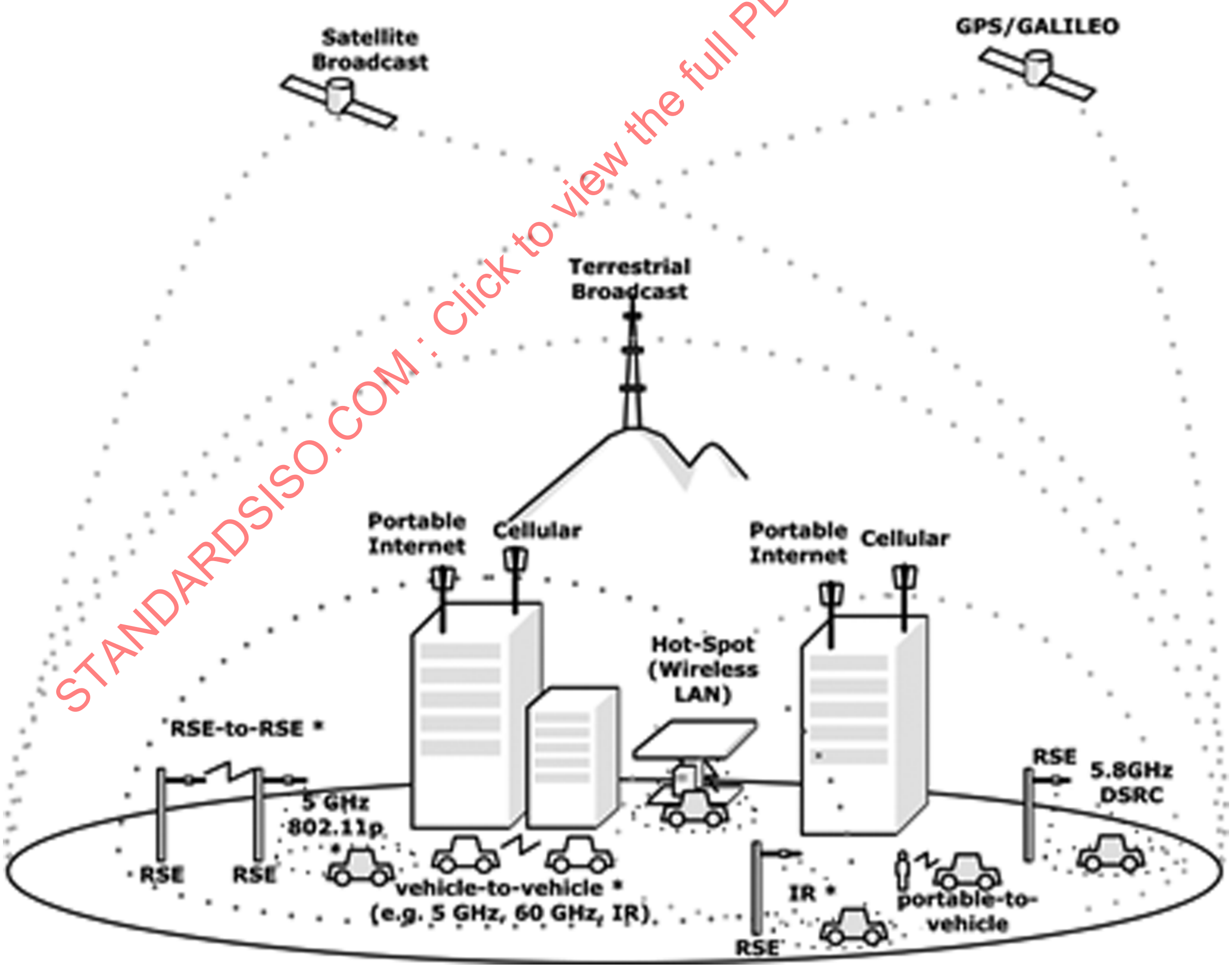


Figure 1 — Examples of wireless links employing various access technologies

5.2.2 Access technologies

The access technologies shown in Figure 1 with an asterisk are each fully specified by a CALM International Standard, e.g. M5 (ISO 21215), IR (ISO 21214) and MM (ISO 21216). These access technologies have been developed with a specific focus on ITS deployment.

The other access technologies shown in Figure 1 are examples of legacy access technologies. Legacy access technologies are specified by reference to the standards according to which they operate (see, for example, ISO 25111). For these legacy access technologies, an adaptation as specified in ISO 21218 can be required in order to fit to the communication and station management entity, to the security entity and to the networking and transport layer; see Figure 14.

Regionally specified DSRC systems may be supported in ITS-Ss as specified in ISO 24103 and ISO 29281. Applications based on the DSRC standards ISO 15628:2007 or EN 12795:2003 can be supported in the ITS environment as specified in ISO 29281.

Positioning data from satellite networks such as GPS, GALILEO or GLONASS may be received and provided to the related applications, e.g. via the ITS station-internal network presented in Figure 2.

5.2.3 Communication interface

An implementation of an access technology is called a communication interface (CI). The concept of a CI and its virtual communication interfaces (VCIs) are specified in ISO 21218.

5.2.4 Logical channel types

Logical communication channels are a key element of CALM's abstraction of ITS-S applications from the physical communication channels used to transport the information. ITS-S applications communicate through logical channels which are mapped by the ITS-S management to physical channels in CIs. Automatic mapping of ITS-S applications on specific CIs, referred to as “CI selection management”, is specified in ISO 24102.

Definitions of logical channel types are provided in ISO 21218.

5.3 Handover

5.3.1 General

The essential feature of the CALM concept that distinguishes it from traditional communication systems is that applications are abstracted from the access technologies that provide the wireless connectivity and the networks that transport the information from the source to the destination(s). ITS-Ss are not limited to a single access technology and networking protocol and can implement any of those supported, and the ITS-S management can make optimal use of all these resources. To exploit this flexibility, CALM-compliant systems provide the ability to support handover of different types including

— those involving a change of CI (which may or may not involve a change of access technology, since ITS-Ss may have multiple communication interfaces using the same access technology,

— those involving reconfiguration or change of the network employed to provide connectivity, and

— those involving both a change in communication interface and network reconfiguration.

The following examples illustrate the various types of handover that are possible.

— Homogeneous handover:

  Maintaining a session between an ITS-S application in a vehicular ITS subsystem and an ITS-S application in a central ITS subsystem using subsequent roadside ITS-Ss along the road of the same roadside subsystem, using the same access technology in the various ITS-Ss.

— Heterogeneous handover:

Maintaining a session between an ITS-S application in a vehicular ITS subsystem and an ITS-S application in a central ITS subsystem by switching from a dedicated CALM access technology, e.g. M5 or IR, to a public cellular network.

5.3.2 Network domains

The top-level point of view of networking supported by ITS is presented in Figure 2.

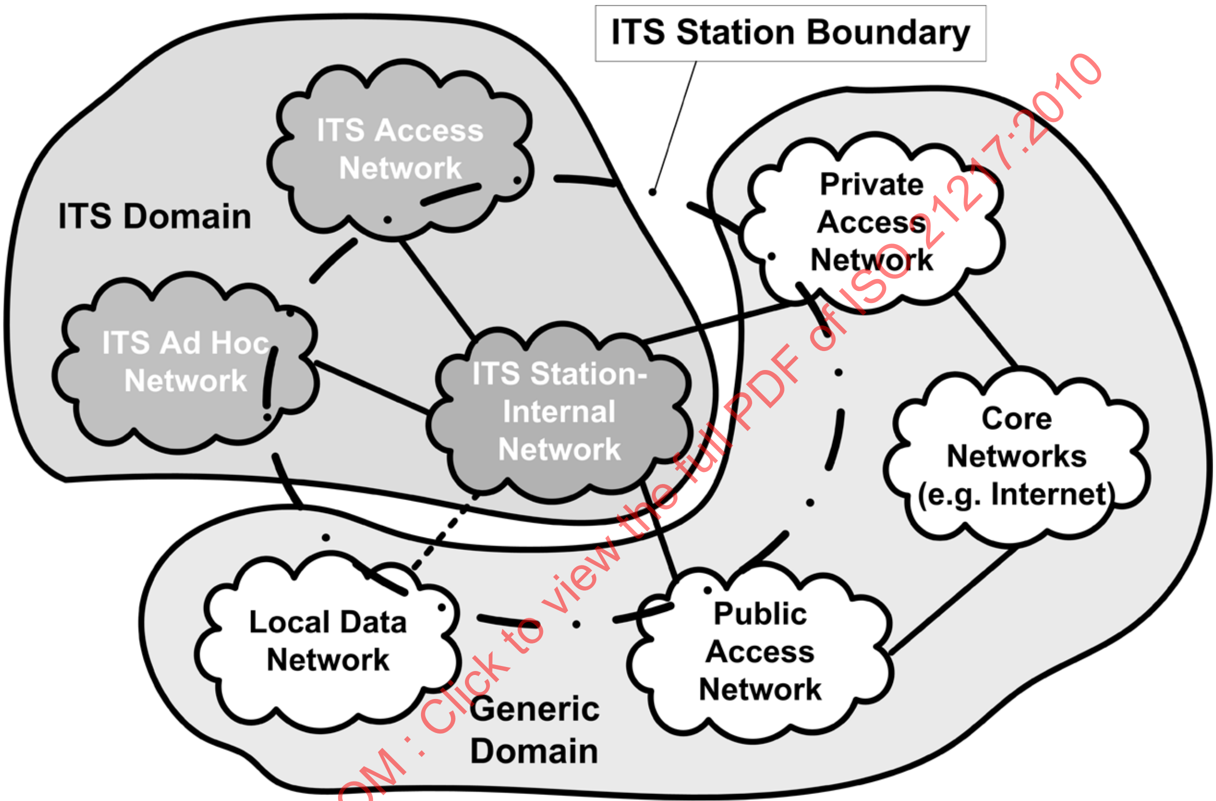


Figure 2 — Top-level networking view

Two domains are distinguished, i.e.

— the ITS domain, and

— the generic domain.

Possible networks in the ITS domain are

— the ITS station-internal network,

— the ITS ad-hoc network, and

— the ITS access network.

NOTE 1 The concept of an ITS-S is presented in Figure 14.

NOTE 2 The ITS station-internal network may be realized simultaneously with different access technologies, both wired, e.g. Ethernet, or wireless, e.g. Bluetooth. See also ISO 21210 and ISO 29281.

Possible networks in the generic domain are

— the local data network (typically a private network),

— the public access network,

— the private access network, and

— the core networks.

The boundary of an ITS-S is indicated in Figure 2. The ITS-S connects to the local proprietary data network via an ITS-S gateway, as presented in Figure 15, i.e. the vehicle gateway in Figure 4, the roadside gateway in Figure 5 and the central gateway in Figure 7. The ITS-S connects to the access networks via ITS-S border routers, as presented in Figure 17, i.e. the routers presented in Figures 5 and 7.

5.4 ITS subsystems and ITS-Ss

5.4.1 Peer-to-peer communication

Figures 4, 5, 6 and 7 present four ITS subsystems, i.e. vehicular ITS subsystem, roadside ITS subsystem, personal ITS subsystem and central ITS subsystem.

The essential element in every ITS subsystem is the ITS-S compliant with the ITS-S reference architecture presented in Figures 13 and 14. ITS-S subsystems are introduced for the sole purpose of illustrating the different implementation possibilities of ITS-Ss. All communications between ITS-Ss is peer-to-peer, as illustrated in Figure 3, regardless of the ITS-S locations relative to the networks involved in the connection.

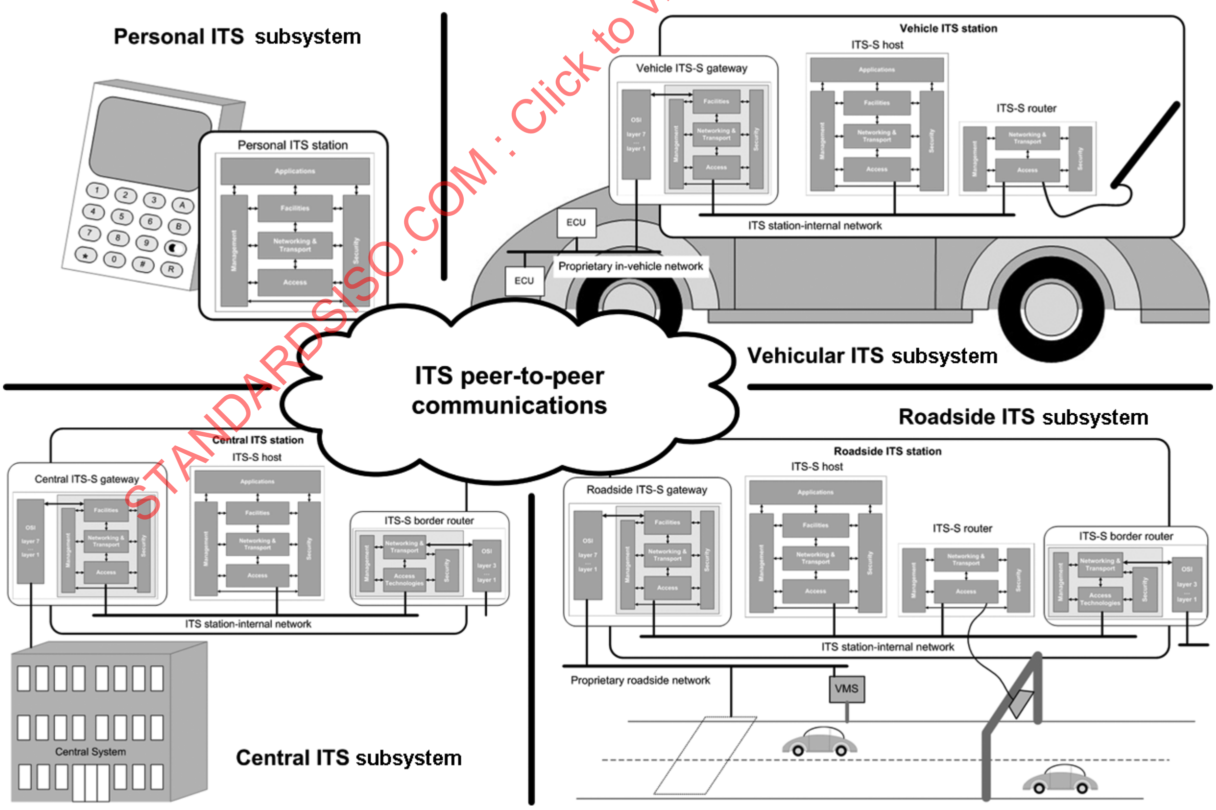


Figure 3 — ITS subsystems and peer-to-peer communications

Figures 4, 5, 6 and 7 distinguish ITS-S hosts and ITS-S routers in accordance with Figure 16, although this functionality is completely covered by the concept of an ITS-S. This distinction illustrates that in an implementation, the overall functionality of an ITS-S may be provided in several distinct physical units, where several physical units with the same functionality may also exist.

ITS-S gateways in accordance with Figure 15 and ITS-S border routers in accordance with Figure 17 are presented in order to show that the interconnection with proprietary and public networks is not CALM compliant.

5.4.2 Vehicular ITS subsystem

The vehicular ITS subsystem presented in Figure 4 contains a vehicle ITS-S. The vehicle ITS-S may be physically split into ITS-S hosts, ITS-S routers and the CALM-compliant part of the vehicle ITS-S gateway. A passenger may use a personal ITS-S, as presented in Figure 6, which uses an HMI and forms an integral part of the vehicular ITS-S.

The vehicle ITS-S gateway supports functionality in order to connect to the ITS-S host and the ITS-S router via the ITS station-internal network presented in Figure 2. The part of the vehicle ITS-S gateway which connects to the proprietary in-vehicle network and the ECUs is outside the scope of this International Standard.

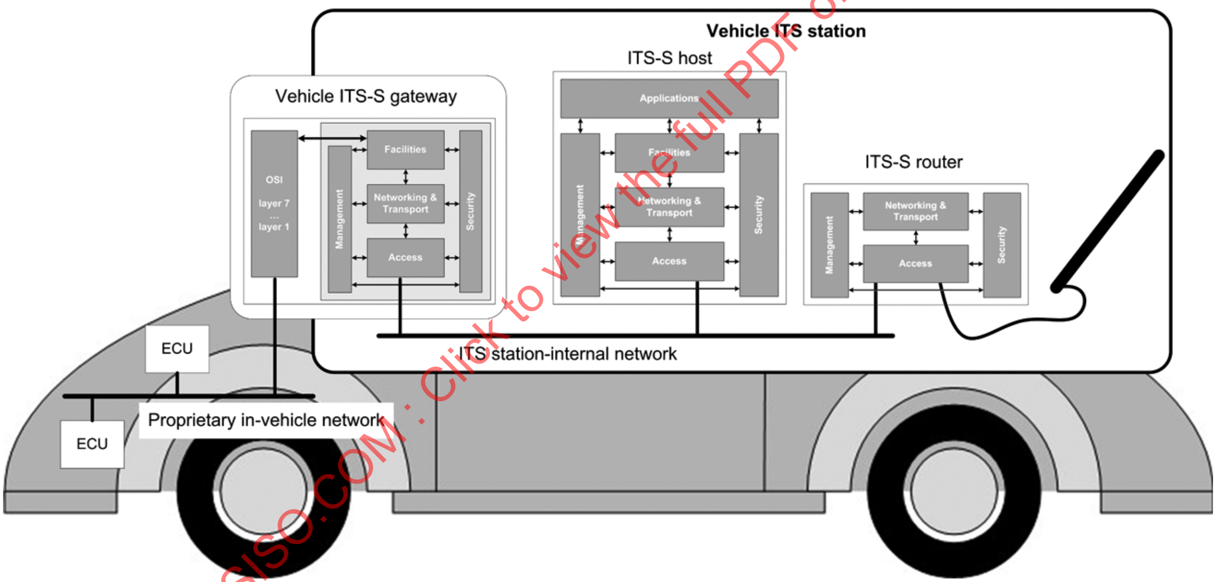


Figure 4 —Vehicular ITS subsystem

5.4.3 Roadside ITS subsystem

The roadside ITS subsystem presented in Figure 5 contains a roadside ITS-S. The roadside ITS-S may be physically split into ITS-S hosts, ITS-S routers and the CALM-compliant parts of roadside ITS-S gateways and ITS-S border routers. In this context, the ITS-S router is also called access router.

The roadside ITS-S gateway supports functionality in order to connect to the ITS-S hosts, the ITS-S routers and the ITS-S border routers via the ITS station-internal network presented in Figure 2. The part of the roadside ITS-S gateway which connects to the proprietary roadside network and the roadside components such as VMS, inductive loops, etc., is outside the scope of this International Standard.

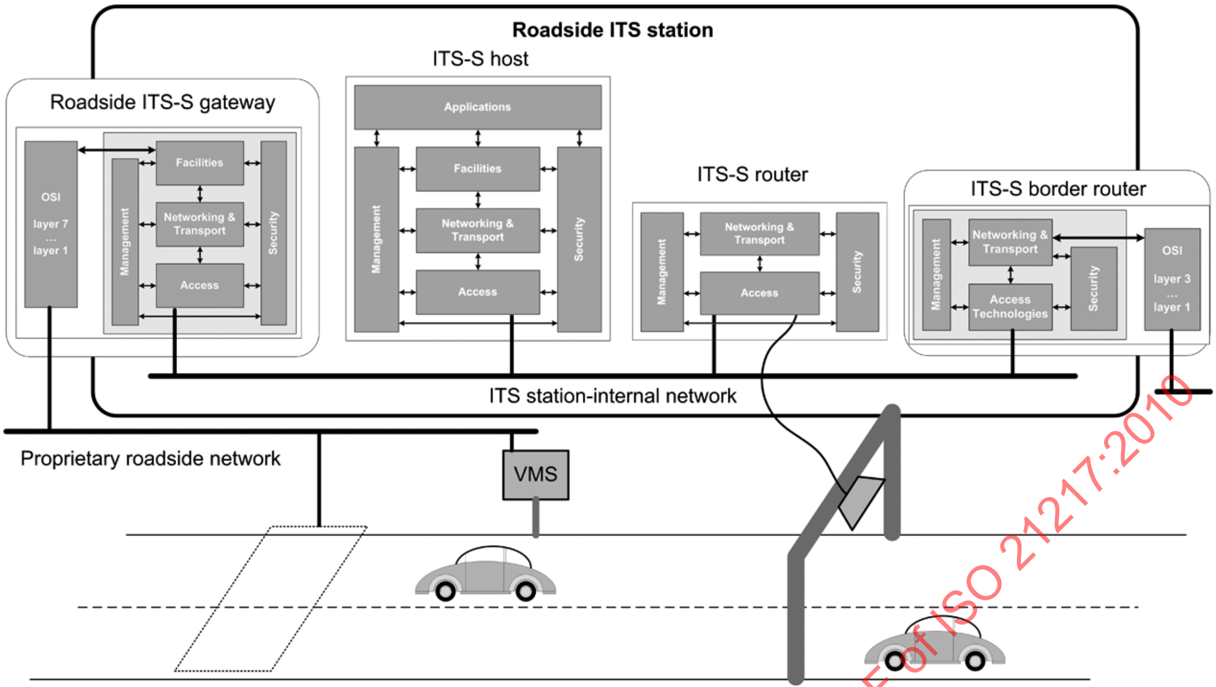


Figure 5 — Roadside ITS subsystem

5.4.4 Personal ITS subsystem

The personal ITS subsystem presented in Figure 6 provides the ITS-S functionality in consumer electronic devices such as PDAs and mobile phones. It contains a personal ITS-S. Portable devices, e.g. PDAs, cellular phones, with ingress connectivity (provided by Bluetooth, for example), in addition to connectivity to public wireless network services, may be used as egress access technologies for ITS-Ss. Portable devices, e.g. laptops and media players, can use the vehicle as an access point for longer range connectivity. This is handled by the ITS-S router functionality and the use of IPv6 protocols specified in ISO 21210.

Personal area network devices, such as those using Bluetooth in accordance with IEEE 802.15.2:2003 and IEEE 802.15.4:2006 compliant platforms, may be used to provide local connectivity for portable devices.

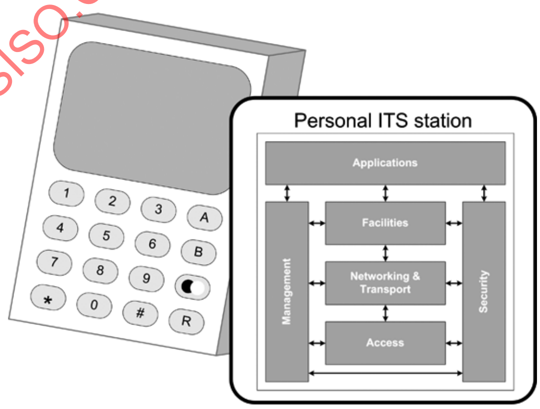


Figure 6 — Personal ITS-S (portable device)

5.4.5 Central ITS subsystem

The central ITS subsystem presented in Figure 7 contains a central ITS-S. The central ITS-S may be physically split into ITS-S hosts and the CALM-compliant part of central ITS-S gateways and ITS-S border routers.

The central ITS-S gateway supports functionality in order to connect to the ITS-S host and the central ITS-S border router via the local data network presented in Figure 2. The interface to the central system is outside the scope of this International Standard.

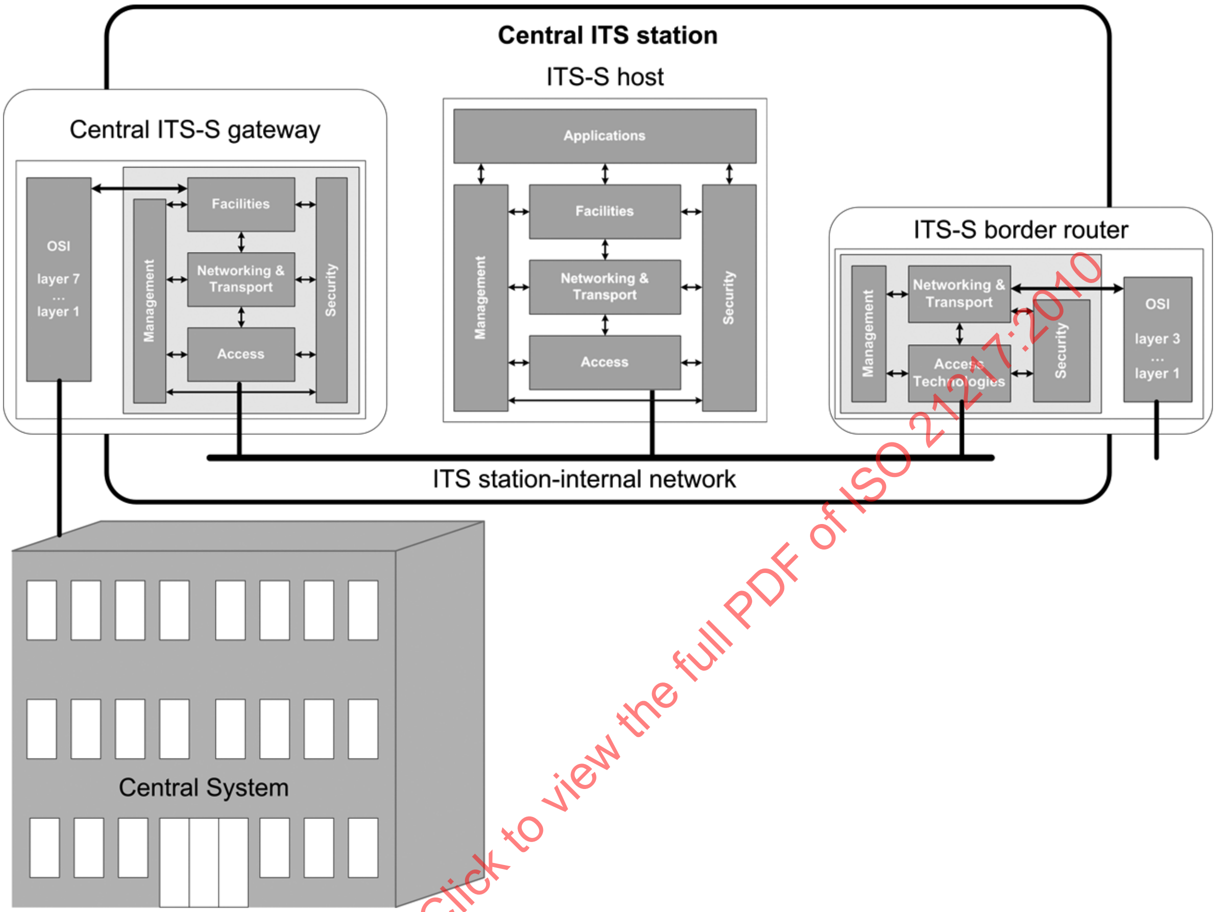


Figure 7 — Central ITS-S

5.5 Communication scenarios and classes

5.5.1 Communication scenarios

Four basic communication scenarios are identified, as illustrated in Figures 8, 9, 10 and 11. The distinction between these scenarios is based on two criteria:

a) whether the CALM-compliant ITS-S is connected to the final peer station

1) with a single-hop link, or

2) via a network;

b) whether the final peer station is

1) also a CALM-compliant ITS-S, or

2) a legacy station.

NOTE 1 This classification of scenarios does not consider any details of the network between CALM-compliant ITS-S and peer station.

NOTE 2 These communication scenarios are in no way restricted to a specific communication mode, i.e. broadcast, multicast or unicast mode.

NOTE 3 The ITS-S connecting to the peer station may be either the original source of a data packet or may act as a forwarding station.

Single-hop communication between two CALM-compliant ITS-Ss is presented in Figure 8. This can represent, for example, a link between two vehicle stations, or between a vehicle station and a roadside station, or between a personal station and a vehicle station.

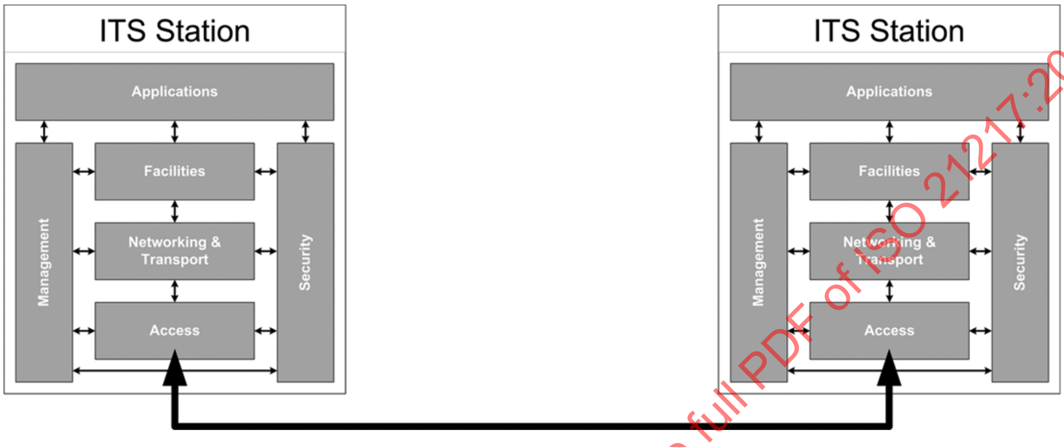


Figure 8 — Scenario I — ITS-S to ITS-S via single-hop link

Communication between two CALM-compliant ITS-Ss involving network connectivity is illustrated in Figure 9. This can represent, for example, a peer-to-peer communication involving a single-hop link from the ITS-S to a base station of a cellular network which is connected to the Internet which also provides the connection to the ITS-S of a central subsystem.

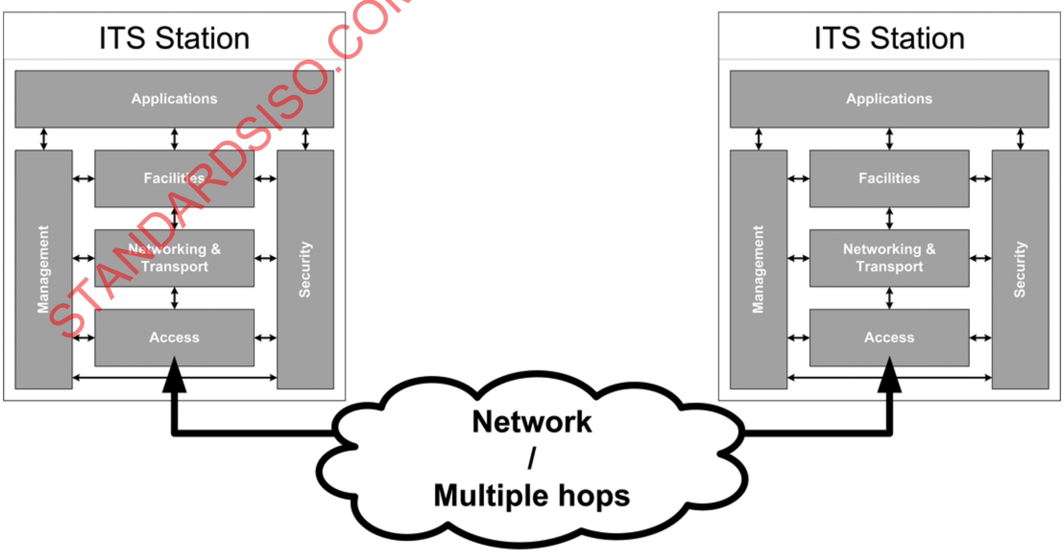


Figure 9 — Scenario II — ITS-S to ITS-S via network (multiple hops)

Single-hop communication between a CALM-compliant ITS-S and a legacy station is illustrated in Figure 10. This can represent, for example, a link between a DSRC CI implemented in a vehicle ITS-S, as specified in ISO 29281, and a legacy DSRC roadside station.

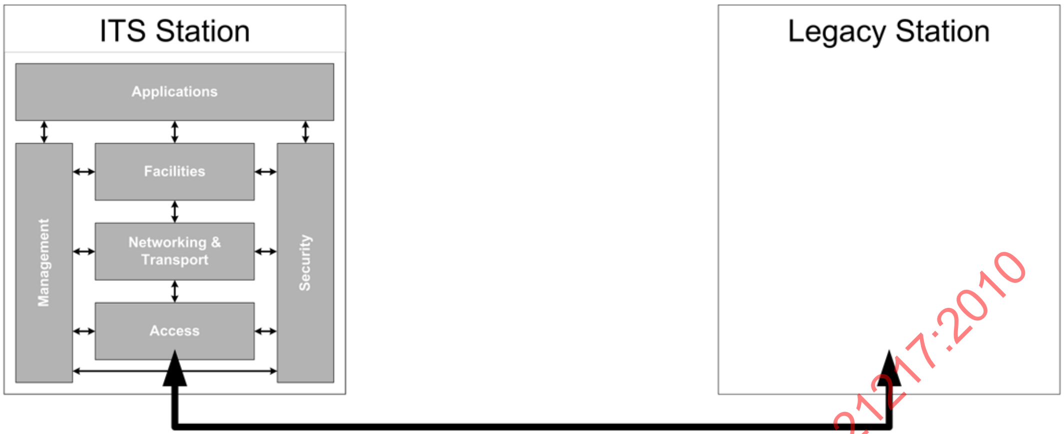


Figure 10 — Scenario III — ITS-S to legacy peer station via single-hop link

Communication between a CALM-compliant ITS-S and a legacy station involving network connectivity is illustrated in Figure 11. This can represent, for example, a single-hop link from the ITS-S to a base station of a cellular network which connects to the Internet which also provides the connectivity to the legacy station.

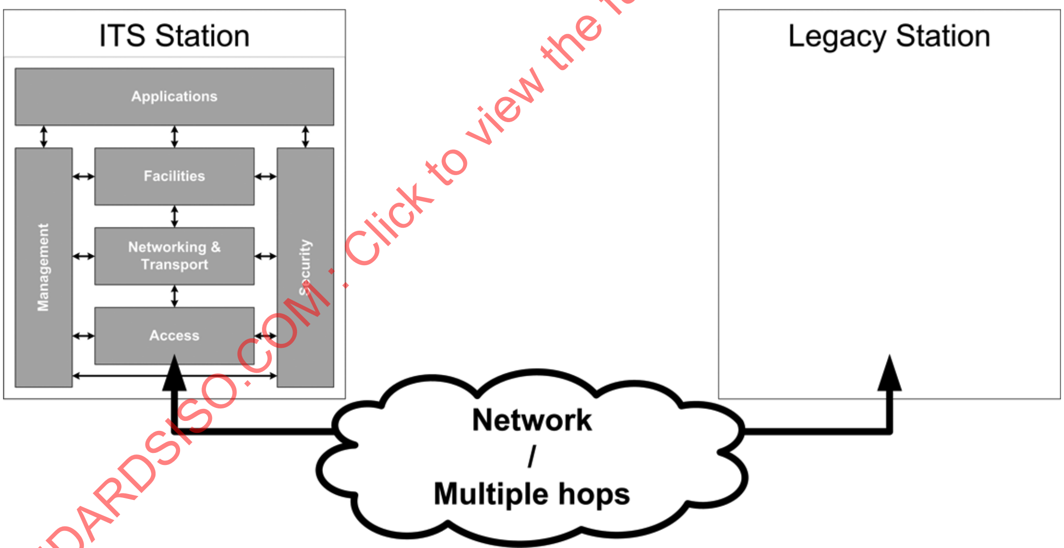


Figure 11 — Scenario IV — ITS-S to legacy peer station via network (multiple hops)

An ITS-S may have multiple simultaneously active sessions involving any or all of these basic communication configurations.

A further illustration of scenarios by means of examples is provided in Annex B.

5.5.2 Communication classes

Table 1 gives a general classification of communications in the ITS environment with respect to multi-hopping, networking, handover and internet access, and the relation to CALM-related International Standards.

An ITS-S may support several communication classes in a sequence or simultaneously.

Table 1 — Communication classes

Comm.[a] class	Multi-hop[b] support	Networking[c] type	Handover support	Internet access	Related International Standard/comment
1	no	non-IP[d]	no	no	ISO 29281
2	no	non-IP[d]	yes	no	ISO 29281
3	no	IPv6	no	no	ISO 21210
4	no	IPv6	yes	no	ISO 21210
5	no	non-IP[d]	no	yes	ISO 24103
6	no	non-IP[d]	yes	yes	Standard not yet under development
7	no	IPv6	no	yes	ISO 21210
8	no	IPv6	yes	yes	ISO 21210
9	yes	non-IP[d]	no	no	ISO 29281
10	yes	non-IP[d]	yes	no	ISO 29281
11	yes	IPv6	no	no	Standard not yet under development
12	yes	IPv6	yes	no	Standard not yet under development
13	yes	non-IP[d]	no	yes	Standard not yet under development
14	yes	non-IP[d]	yes	yes	Standard not yet under development
15	yes	IPv6	no	yes	Standard not yet under development
16	yes	IPv6	yes	yes	Standard not yet under development

[a] "Comm." stands for communication.

[b] Refers to multi-hop from ITS-S to ITS-S performed by the networking protocol.

[c] Indicates the networking protocol used in the air-link.

[d] Refers to protocols specified in ISO 29281.

5.6 ITS-S architecture

5.6.1 General

The "ISO Open Systems Interconnect Reference Model" (i.e. OSI, see ISO/IEC 7498-1:1994) is used in a number of figures within this International Standard with reference to the communications architecture of ITS-Ss that embody the CALM concept. Several levels of abstraction will be used to illustrate different points of view.

5.6.2 Data flow in the OSI protocol stack

Figure 12 shows the general case of flow of data, i.e. service data units (SDU) and protocol data units (PDU), through the OSI layers of two peer stations communicating with each other, and the grouping of protocol layers as used in ITS:

— Session, presentation and application OSI layers 5-7 comprise the "Facilities layer".

— Network and transport OSI layers 3-4 comprise the "Networking & transport layer".

— Physical interface and link control OSI layers 1-2 comprise the "Access layer".

NOTE In a draft of this International Standard, the groups of OSI layers identified for ITS were given different names. "Facilities layer" was called "CALM service layer", "Networking & transport layer" was called "CALM networking", and "Access layer" was called "CALM CI layers".

The naming and usage of service data units (SDU) and protocol data units (PDU) follows the principles outlined in ISO/IEC 8802-2:1998.

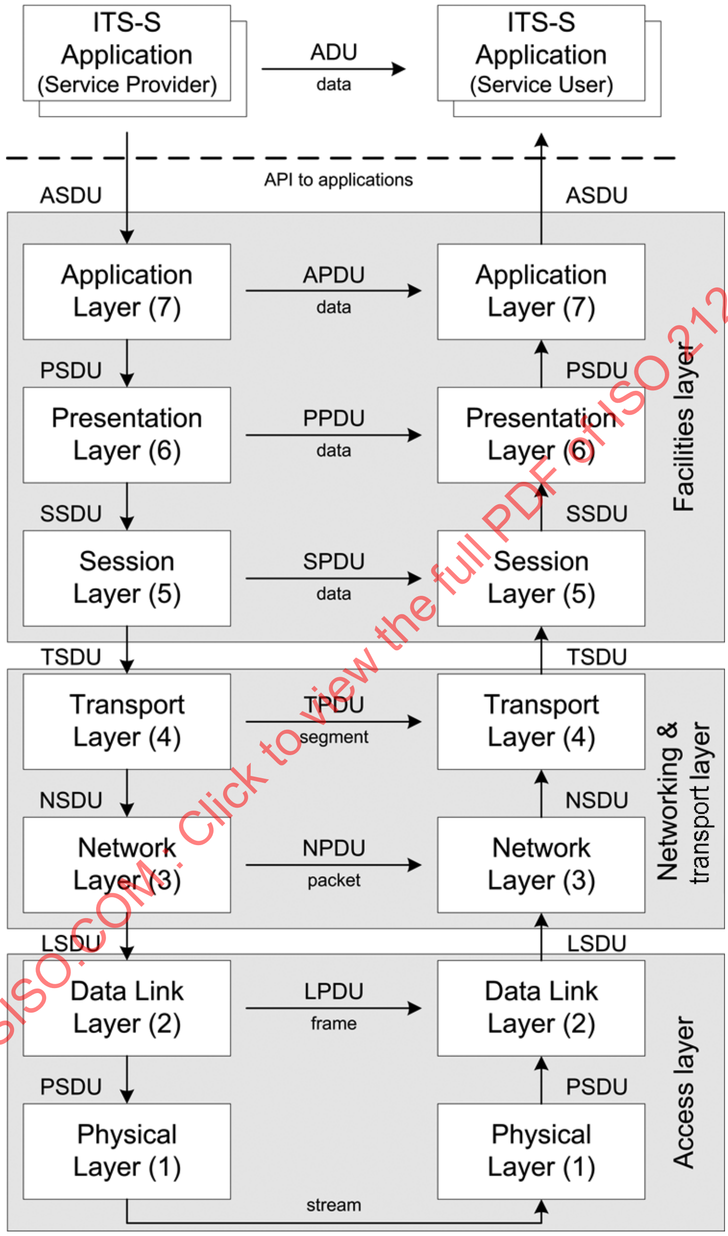


Figure 12 — OSI data flow

Figure 13 illustrates a simplified view of the communications architecture of an ITS-S embodying the CALM concept, where

— the security functionality and,

— the management functionality

are added to the OSI layers and the ITS-S applications; see also the ITS-S reference architecture in Figure 14.

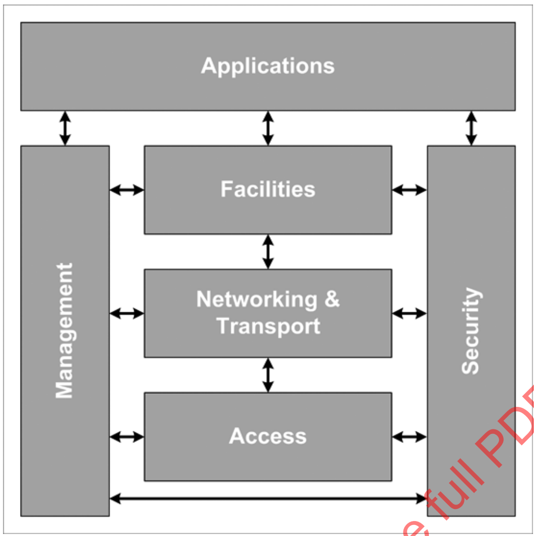


Figure 13 — Simplified ITS-S reference architecture

The functionality of all blocks presented in Figure 13 shall be provided by an ITS-S that is compliant with this International Standard.

This requirement does not imply anything about the implementation; these blocks may be spread over several physical devices, or they may be implemented inside a single device.

5.6.3 ITS-S reference architecture

5.6.3.1 General

Figure 14 shows the general ITS-S reference architecture, including interfaces between the various blocks with informative details. Such interfaces may be partly non-observable and thus non-testable service access points (SAPs), or observable and testable interfaces.

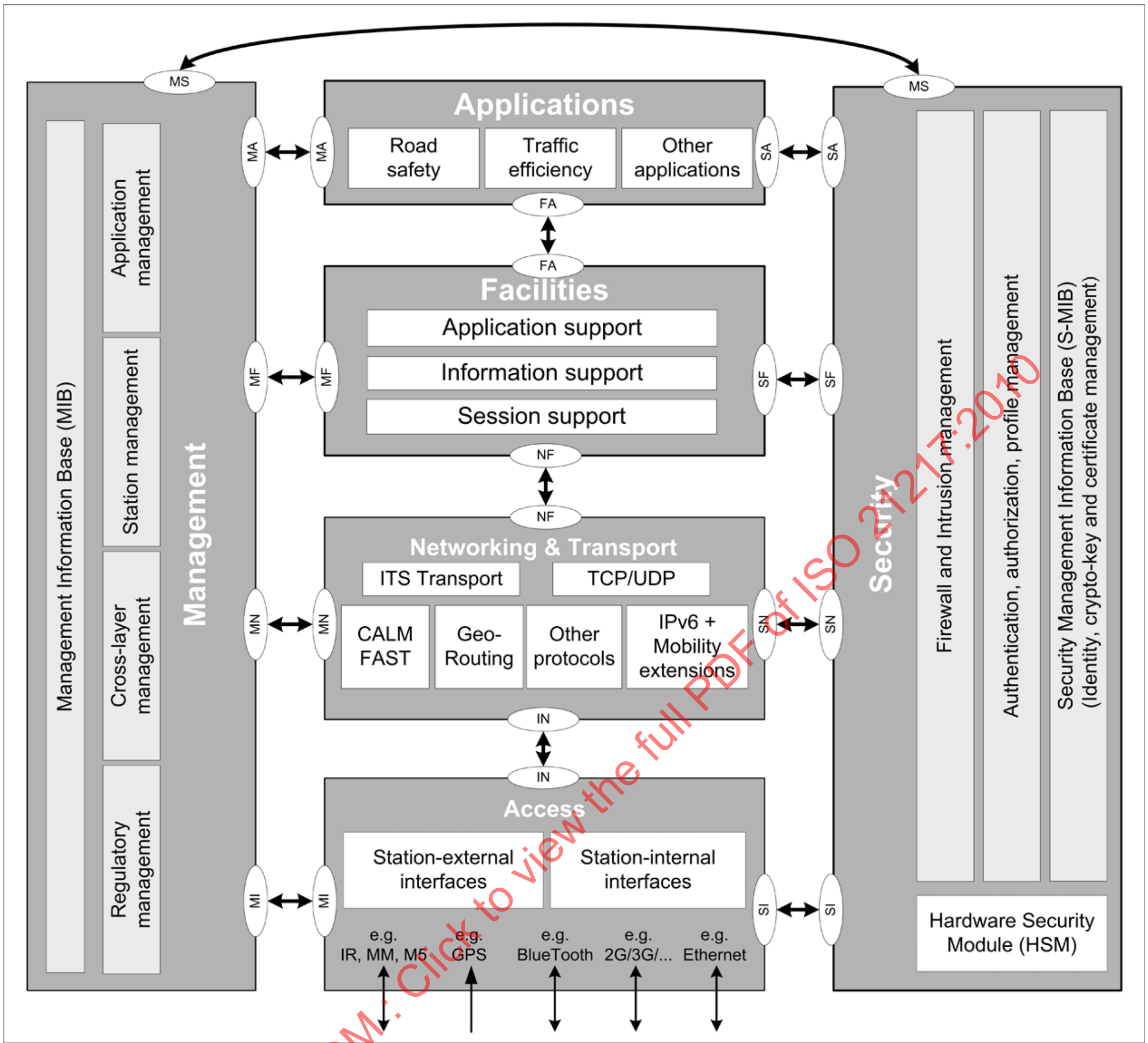


Figure 14 — ITS-S reference architecture

Five categories of interface are described in detail in 5.6.3.2 to 5.6.3.6.

5.6.3.2 Interfaces towards the management entity

— MI:
Enables the management entity to interact with the access layer (OSI layers 1 and 2/communication interfaces).

NOTE 1 This interface was formerly known as “M-SAP”.

— MN:
Enables the management entity to interact with the networking and transport layer (OSI layers 3 and 4).

NOTE 2 This interface was formerly known as “N-SAP”.

— MF:
Enables the management entity to interact with the facilities layer (OSI layers 5 through to 7).

NOTE 3 This interface was formerly known as “A-SAP”.

— MA:
Enables the management entity to interact directly with ITS-S applications.

5.6.3.3 Interfaces towards the security entity

- SI:
  Enables the security entity to interact with the access layer (OSI layers 1 and 2/communication interfaces).

- SN:
  Enables the security entity to interact with the networking and transport layer (OSI layers 3 and 4).

- SF:
  Enables the security entity to interact with the facilities layer (OSI layers 5 through 7).

- SA:
  Enables the security entity to interact directly with ITS-S applications.

5.6.3.4 Interface between access layer and networking and transport layer

IN:
Allows the networking and transport layer and the access layer to interact with each other. Typically implemented as a SAP.

NOTE This interface was formerly known as “C-SAP”.

5.6.3.5 Interface between networking and transport layer and facilities layer

NF:
Allows the facilities layer and networking and transport layer to interact with each other. Typically implemented as a SAP.

NOTE This interface was formerly known as “T-SAP”.

5.6.3.6 Interface between facilities layer and ITS-S applications

FA:
Allows the facilities layer to interact with ITS-S applications. Typically implemented as an API.

NOTE A valid implementation option is to merge the IN, MI and SI interfaces into a plug-and-play interface, e.g. according to a system specification.

5.6.4 Host, router and gateway architecture

Following the principles of the ITS-S reference architecture presented in Figures 13 and 14, the functionality of its subsets is identified as follows.

- An ITS-S host provides the functionality, as presented in Figure 13. It provides, as a minimum, the ITS-S applications and the means to connect to the ITS-S-internal network.

- An ITS-S gateway provides the functionality, as presented in Figure 15. It interconnects two different OSI protocol stacks at layers 5 through to 7. It shall be capable of converting protocols.

- An ITS-S router provides the functionality, as presented in Figure 16. It interconnects two different CALM protocol stacks at layer 3. It may be capable of converting protocols.

  NOTE A router implementation can contain more functionality than presented in Figure 16.

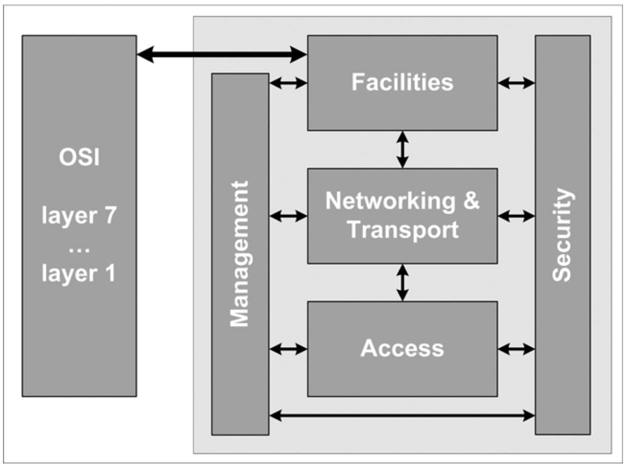


Figure 15 — ITS-S gateway

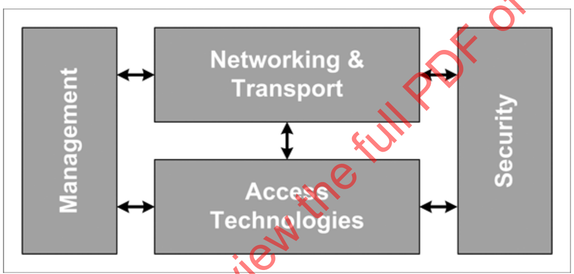


Figure 16 — ITS-S router

An ITS-S border router, as presented in Figure 17, basically provides the same functionality as the ITS-S router presented in Figure 16. The difference is that the protocol stack related to the external network might not follow the management and security principles of CALM.

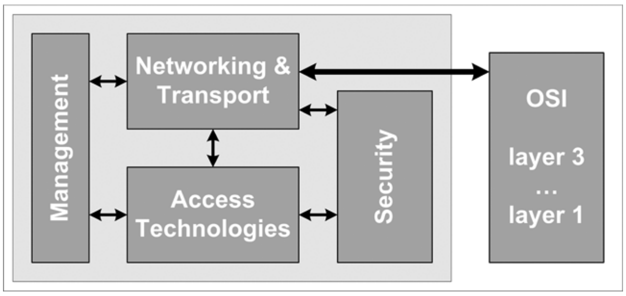


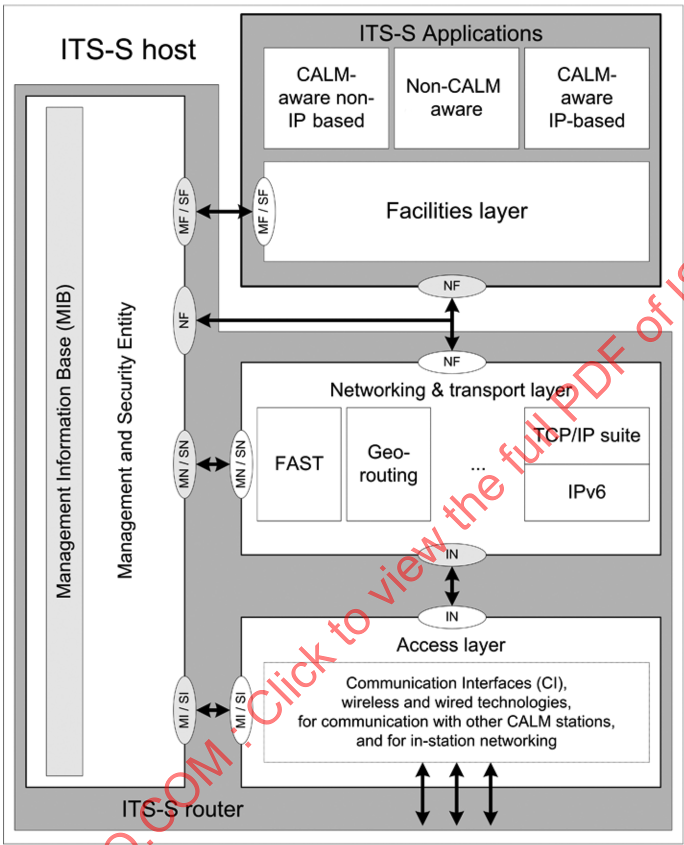
Figure 17 — ITS-S border router

5.7 CALM communications kernel

Figure 18 illustrates the concept of a CALM communications kernel (CCK), as specified in ISO 24102.

NOTE 1 The term CCK was introduced at an early stage of CALM standardization. Following the latest terminology applied in this International Standard, the CCK provides the functionality of an ITS-S router. An instance of the ITS-S router functionality is referred to as a CCK, which can be identified by means of a CCK-ID, unique in an ITS-S.

NOTE 2 From an IP point of view, a CCK acts as a “node”. However, the IP term “node” does not sufficiently specify the functionality of a CCK.



NOTE The elements shown in Figure 18 inside the blocks “Facilities layer”, “Networking & transport layer” and “Access layer” are considered to be examples of optional elements.

Figure 18 — CALM communications kernel (CCK) as an instance of an ITS-S router

5.8 Services

5.8.1 ITS service

The term “ITS service” in the context of CALM refers to a service provided by an ITS application to a user of an ITS-S. The ITS application itself consists of two or more complementary ITS-S applications. Pairs of ITS-S applications may be classified as, for example, server/client applications.

A client station can identify available user services in the two following ways.

— User service discovery.

A client station actively tries to discover user services.

— User service notification.

A server station is actively broadcasting service notification messages in service announcements. These service announcements are managed through various processes, including application registration and announcement requests, and construction of such announcement messages is to be transmitted over the air with an appropriately chosen access technology.

Details may depend on networking protocols used.

FAST communications, as specified in ISO 29281, are based on service notification. The details of these procedures are specified in ISO 24102. A client station receiving an announcement message can either

— use this announcement message, as it already contains the complete service information, e.g. traffic situation alert message,

— reply to the notification with a privately addressed frame containing service context information, upon which the server shall run the service transaction in the correct context, if applicable, or

— run the service transaction.

NOTE ITS-Ss communicate in a peer-to-peer mode where, once the application association has been made, data exchanges between applications occur until such time as the session is complete or the link between the applications is broken.

ITS-S applications use ITS-S services in order to connect to one or more other ITS-S application. In implementations with more than one wireless communication interface, quasi-simultaneous provision of ITS-S services with data streams via different CIs is supported.

5.8.2 ITS-S service

The term "ITS-S service" in the context of CALM refers to a communication functionality offered by an ITS-S to an ITS-S application. An ITS-S service provides the complete communication link through all the OSI layers (facilities, networking) down to a communication interface and via the medium to a peer station.

5.9 Details related to the access layer

Figure 19 shows elements of the access layer. The access layer is part of the ITS-S reference architecture presented in Figure 14.

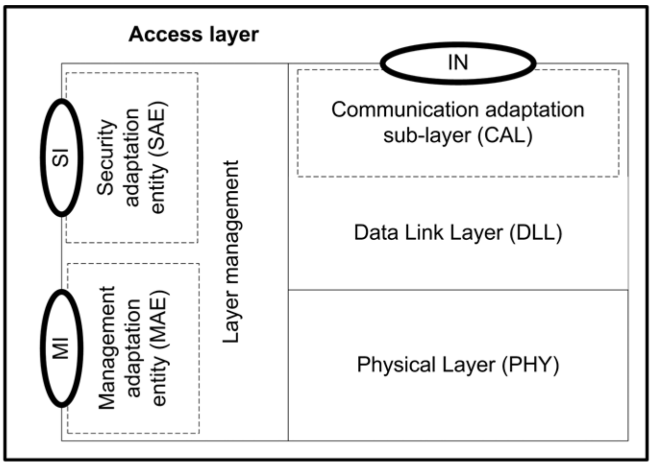


Figure 19 — Elements of access layer

The access layer consists of

— a physical (PHY) layer and a data link layer (DLL), as illustrated in Figure 12,

— layer management,

— optional elements for adaptation needed for legacy access technologies,

— the interfaces

  — MI to the communication and station management,

  — SI to the security entity, and

  — IN to the networking and transport layer,

as illustrated in Figure 14.

The ITS architecture accommodates several distinct PHY layers. Three different groups are distinguished.

a) The first group deals with wireless interfaces out of the vehicle or out from infrastructure. The wireless modes of cellular 2nd generation, cellular 3rd generation, infra-red, 5 GHz, and 60 GHz are shown in Figure 1. Each of these uses different frequency bands in the electromagnetic spectrum and different communication interface deployment strategies. See the CALM International Standards on specific access technologies, such as ISO 21212, ISO 21213, ISO 21214, ISO 21215 and ISO 21216 for more detail.

b) The second group of interfaces are wired interfaces, e.g. internally in a vehicle or connecting infrastructure equipment. These wired interfaces are used for station-internal networking; see the ITS station-internal network in Figure 2.

c) The third group of interfaces are wireless interfaces for station-internal networking, i.e. functionally equivalent to the wired interfaces.

This list of access technologies is not complete. Standards at other frequencies may be added, as appropriate. Other wireless access technologies standardized by other bodies may be added in a similar manner as for cellular. Certain minimum protocol functions and performance yield are required to work seamlessly as a CALM-compliant access technology; see ISO 21218.

NOTE Wired interfaces work to their own protocols, which can conform to International Standards or can be proprietary. There is no intention to develop International Standards for these wired interfaces as part of CALM. Certain protocol functions and minimum performance requirements apply to achieve overall performance; see ISO 21218.

The data link layer consists of a MAC sub-layer and an LLC sub-layer, as specified in ISO 21218.

There is a dedicated MAC sub-layer for every PHY layer. Details of the MAC layer will be specified together with the related PHY layer in future International Standards and will be referenced in the appropriate access technology standards. Legacy MAC layers do not need to be modified in order to be used as part of a CALM-compliant communication interface.

Adaptation is an optional functionality, the implementation of which is necessary only for legacy access technologies.

The roles of the CALM communication adaptation layer (CAL) and the management adaptation entity (MAE) specified in ISO 21218 are to provide a common interface between each specific data link layer and the common functionality of the networking and transport layer. CAL and MAE are dedicated to a specific access technology. CAL provides the IN interface to the networking and transport layer following the principles determined in ISO/IEC 8802-2:1998. CAL can be interpreted as an LLC extension of existing communication technologies.

The role of the security adaptation entity (SAE) is to provide a common interface to the security entity.

5.10 Details related to the networking and transport layer

Figure 20 shows elements of the networking and transport layer. The networking and transport layer is part of the ITS-S reference architecture presented in Figure 14.

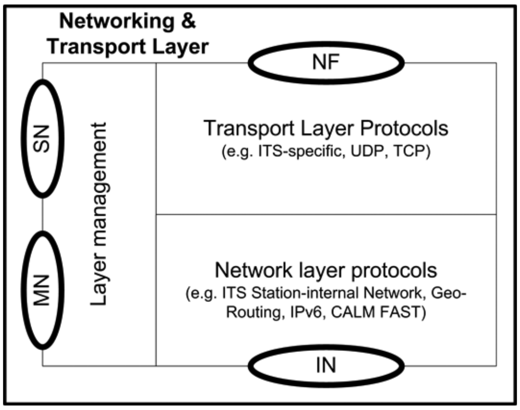


Figure 20 — Elements of the networking and transport layer

The networking and transport layer consists of

- a network layer and a transport layer, as illustrated in Figure 12,
- layer management, and
- the interfaces
  - MN to the communication and station management,
  - SN to the security entity,
  - IN to the access layer, and
  - NF to the facilities layer,

as presented in Figure 14.

The network layer connects the data link layer to the transport layer. Multiple optional and complementary network protocols running independent of each other may be supported.

At this time, the two following classes of network protocols are identified.

- Internet protocol

  In order to achieve Internet-based communications, version 6 of the Internet protocol (IPv6) shall be used.

  IPv6 protocols are required for Internet connectivity, session continuity and seamless communications. Details shall be as specified in ISO 21210.

- Non-IP protocols

  Protocol functionality as specified in ISO 29281.

  - FAST is designed for ITS applications with severe timing constraints and low latency requirements, e.g. time-critical safety related applications as illustrated in Reference [16].
  - Geo-routing/geo-networking uses the geo-coordinates to identify target areas of possible destination stations. Road safety and traffic efficiency applications, as illustrated in Reference [1], depend on this protocol functionality.

The transport layer connects the network layer with the facilities layer and provides transparent transfer of data between the communicating entities.

Several transport protocols may be needed to serve different functional needs:

— In addition to IPv6 networking, user datagram protocol (UDP), and optionally transmission control protocol (TCP), may be useful; see ISO 21210.

— In addition to the FAST networking protocol, a dedicated FAST transport protocol as specified in ISO 29281 may be used, also optionally supporting connection-oriented data transfer, reliable data transfer, and multiplexing/de-multiplexing functionality.

5.11 Details related to facilities layer

Figure 21 shows elements of the facilities layer. The facilities layer is part of the ITS-S reference architecture presented in Figure 14.

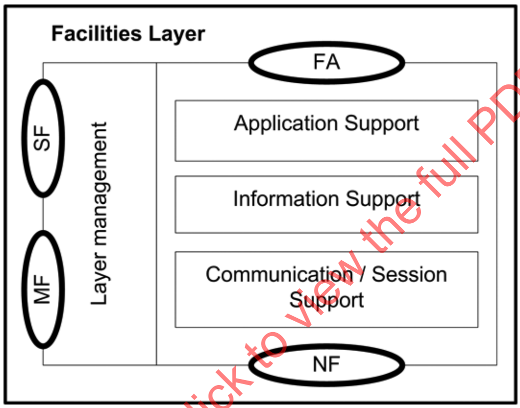


Figure 21 — Elements of the facilities layer

The facilities layer consists of

— a session layer, presentation layer and application layer, as illustrated in Figure 12, providing application support, information support and communication/session support,

— layer management,

— the interfaces

  — MF to the communication and station management,

  — SF to the security entity,

  — FA to the ITS-S applications, and

  — NF to the networking and transport layer.

Details on application support, information support and session/communication support will be provided in a future edition of this International Standard.

5.12 Details related to ITS-S applications

5.12.1 CALM-aware applications

"CALM-aware ITS-S applications" are ITS-S applications that can interact with the ITS-S management by:

— responding to requests from the communication and station management entity for registration information,

— requesting registration at the communication and management entity upon initialization, and

— passing service level requirements to the communication and management entity.

See also ISO 24102.

The following two types of CALM-aware ITS-S applications are distinguished.

a) ITS-S applications that get real-time access to pre-selected parameters of

 — specific communication interfaces in line with applicable regulations, and

 — the networking and transport layer.

 in order to control the real-time behaviour of the communication link. These parameters include power settings, channel settings and beam steering angles. These ITS-S applications typically use the FAST networking or geo-routing protocol specified in ISO 29281.

b) Other ITS-S applications that, typically, use IPv6 networking; see ISO 21210.

5.12.2 Non-CALM-aware applications

"Non-CALM-aware ITS-S applications" are ITS-S applications that can not interact with the ITS-S management as CALM-aware ITS-S applications can do. These ITS-S applications operate under the assumption that a specific transport/networking protocol is used, e.g. a UDP/IP or TCP/IP connection is being established for communication. Such applications may obviate the abstraction from lower layers and may be restricted to a particular lower layer protocol and access technology.

NOTE Examples of non-CALM-aware applications are legacy IP applications, and those built following ISO 15628:2007/EN 12795:2003, as specified in ISO 29281.

5.13 Management elements

ITS-S management (see Figure 14) includes functions such as

— OSI cross-layer management, including regulatory information management,

— management of communication links, and

— ITS application support.

ITS-S management is specified in ISO 24102.

NOTE Management elements covering more than a single instance of an ITS-S, i.e. management elements for global ITS management, are not covered in this International Standard, but might be considered in a future edition.

5.14 Security

The security entity presented in the ITS-S reference architecture (see Figure 14) takes care of overall security functionality.

Communications between ITS-Ss and "Inter-CCK communications", as specified in ISO 24102, may be secured at various OSI layers, and as end-to-end security built into the standards and specifications for the ITS applications.

All ISO standards conforming to the CALM architecture shall ensure the availability/applicability of the necessary mechanisms to satisfy security requirements.

NOTE Development of security functionality is being considered by ISO/TC 204 (WG 16); upon availability of security standards, such information could be incorporated into a future edition of this International Standard.

6 Declaration of patents and intellectual property

The following form is to be used to record the statement of a patent holder whose patented device or design (pending or approved) might have to be used by a person or organization complying with an International Standard (or other ISO or ISO/IEC deliverable).

An electronic copy can be downloaded from the ISO/IEC Information Technology Task Force (ITTF): http://www.iso.org/ittf.

For further requirements, see the related CALM International Standards.

Patent Statement and Licensing Declaration Form for ITU-T/ITU-R Recommendation | ISO/IEC Deliverable

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2				
3				

NOTE For option 3, the additional minimum information that shall also be provided is listed in the "option 3" box above.

Annex A
(informative)

CALM standards reference

Figure A.1 presents an overview of standards developed by ISO/TC 204 for ITS and their scope with respect to the ITS-S reference architecture. The numbers in the boxes are references to the International Standard, future International Standard or other standards, in which the indicated functionality is specified.

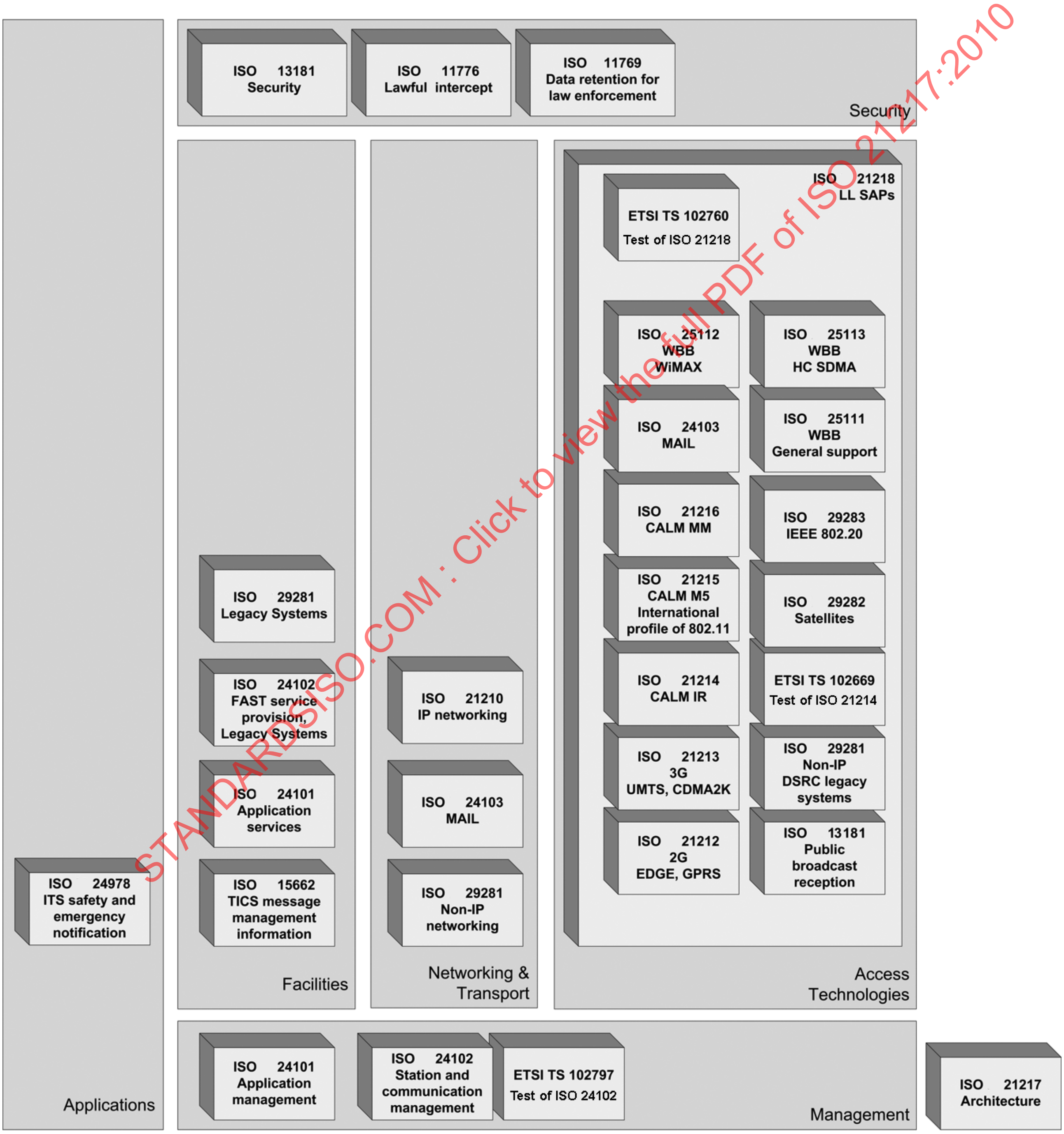

Figure A.1 — Relation between standards and the ITS-S reference architecture