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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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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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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.

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.

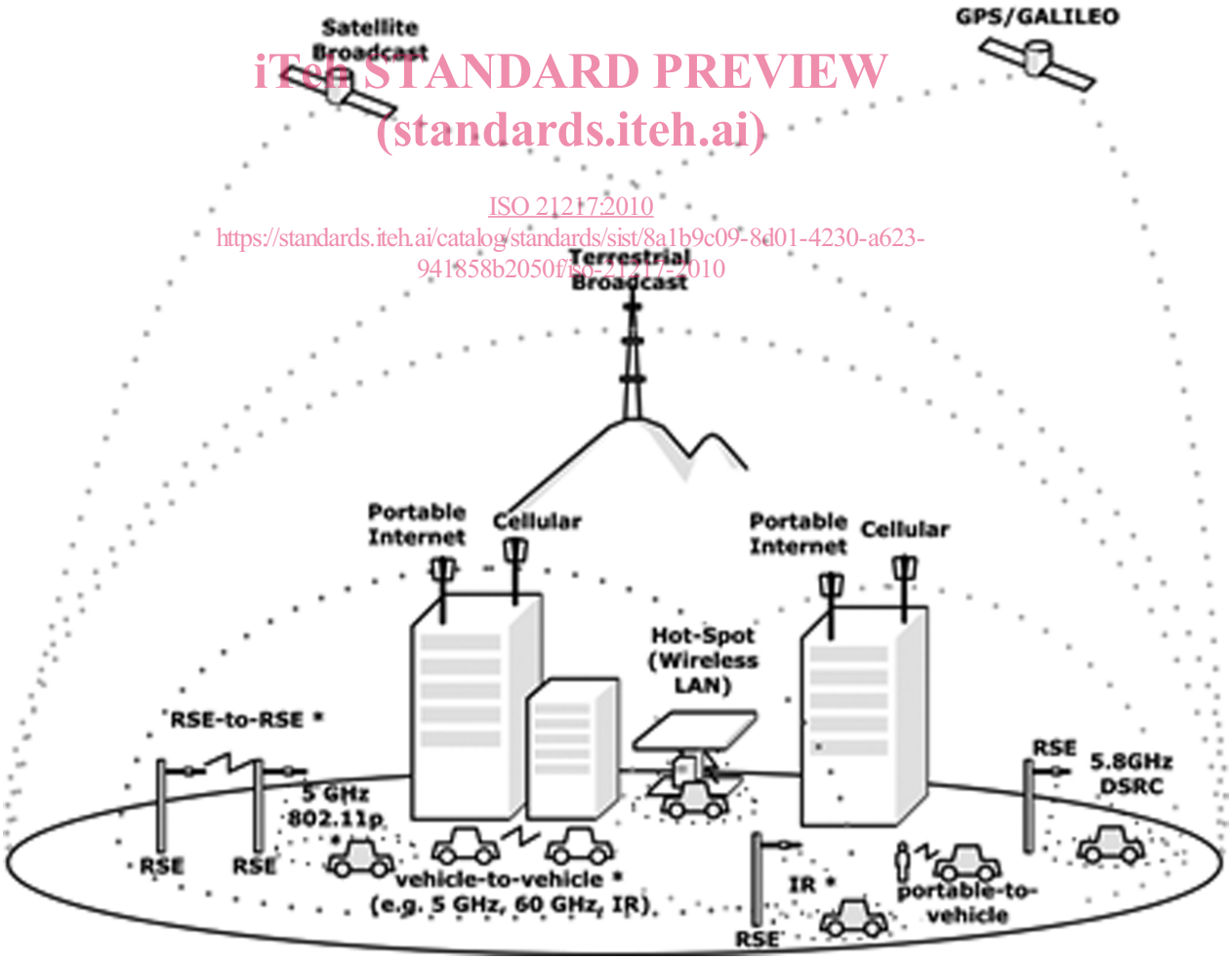

Figure 1 — Examples of wireless links employing various access technologies

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.

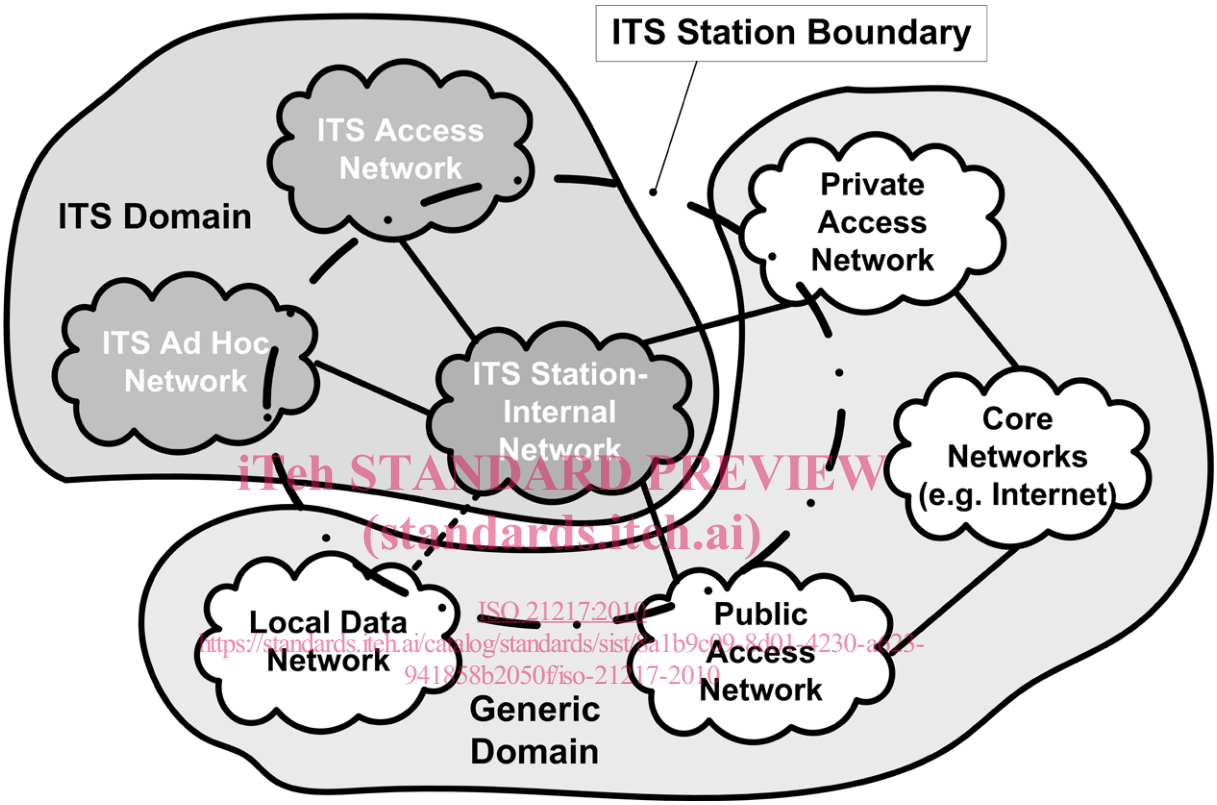

Figure 2 — Top-level networking view

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.