INTERNATIONAL STANDARD

ISO 14813-5

First edition
2010-07-01

Intelligent transport systems — Reference model architecture(s) for the ITS sector —

Part 5: Requirements for architecture description in ITS standards

Systèmes intelligents de transport (ITS) — Architecture(s) de modèle de référence pour le secteur ITS —

Partie 5: Exigences pour la description d'architecture dans les normes ITS

Reference number
ISO 14813-5:2010(E)

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Published in Switzerland

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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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 14813-5 was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems*.

This first edition of ISO 14813-5 cancels and replaces ISO/TR 14813-5:1999, of which it constitutes a technical revision.

ISO 14813 consists of the following parts, under the general title *Intelligent transport systems — Reference model architecture(s) for the ITS sector*:

— *Part 1: ITS service domains, service groups and services*

— *Part 2: Core TICS reference architecture* [Technical Report]

— *Part 3: Example elaboration* [Technical Report]

— *Part 4: Reference model tutorial* [Technical Report]

— *Part 5: Requirements for architecture description in ITS standards*

— *Part 6: Data presentation in ASN.1*

Introduction

"Architecture" can be defined as "*Design; the way components fit together*"[1]. Architecture is implicit in any construction, be it of a physical entity (such as a building), an operational entity (such as a company or organisation), a system entity (such as a software system) or a business entity (such as a commercial business operation).

While it may be stated that every entity has an architecture, the particular architecture may be an explicit construction as a result of a deliberate design process or the implicit result of an unplanned series of events, or sometimes the combination of both.

In physical construction, it is generally recognised that a deliberate design process will produce a better and more efficient building that one where a group of individuals have collected whatever materials happened to be nearby in order to create a shelter.

Intelligent transport systems (ITS) are systems deployed in transportation environments to improve both the driving experience and the safety and security of drivers, passengers and pedestrians. ITS can also assist in the labour, energy, environmental and cost efficiency of transportation systems. It is a feature of most ITS that their architecture involves the collection, use and exchange of information/data within and between software systems which affect or control the behaviour of physical equipment, providing a service to the actors involved in, or interacting with, the transport sector.

In order to maximise the efficiency of co-existing ITS, to obtain compatibility and/or interoperability and to eliminate contention, the systems need to co-exist and operate within a known and supportive architectural framework.

The ITS sector is still emerging and developing and is still close to the start of its evolution and application. The technology is developing and changing rapidly and ITS services have generally to make provision not only for its interaction with other services, but with migration from one technology generation to later iterations.

This part of ISO 14813 is designed to ensure that, in order to obtain maximum interoperability, efficiency and migration capability, architecture is an explicit process in the development of, and specifications defined within, ITS standards.

"Architecture" is used in an informal manner to mean a variety of different concepts and, in formal architecture design, there are differing methodologies and opinions as to their suitability for use in ITS system and standards design. This has limited effective communication in the ITS sector by causing uncertainty as to the meaning of the word when it is used in one context or another. A second function of this part of ISO 14813 is to provide consistent terminology to be used in describing architectural aspects of ITS standards and provide a consistent form for ITS architecture description in standards in the ITS sector.

An ITS architecture is a framework for ITS deployments. It is a high-level description of the major elements and the interconnections among them. It provides the framework around which the interfaces, specifications and detailed ITS designs can be defined. An ITS architecture is not a product design or a detailed specification for physical deployment and is not specific to any one location. "Systems architecture" is perhaps the closest general term, but this is sometimes too specific to include the conceptual aspects included in the term "ITS Architecture" and often also implies a location-specific solution. The purpose of an ITS architecture is to maximise efficiency, interoperability and multimodality of multiple interacting ITS in a complex and developing sector.

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1) *Interoperability Clearinghouse Glossary of Terms,* http://www.ichnet.org/glossary.htm)

This part of ISO 14813 does not give preference to any one methodology for architecture development and description. It requires only that the consideration of architecture be an explicit process that takes into account the interrelationships and interoperability of ITS, and that an architecture description be provided within ITS standards.

This part of ISO 14813 requires that the architecture aspects of ITS standards be described explicitly in each and every ITS standard, and that all such standards be related to the (one or more) ITS service domains, service groups and services set out in ISO 14813-1 that they are designed to enable or support.

Intelligent transport systems — Reference model architecture(s) for the ITS sector —

Part 5: Requirements for architecture description in ITS standards

1 Scope

This part of ISO 14813 gives requirements for the description and documentation of the architecture of intelligent transport systems (ITS) in standards dealing with ITS. It also defines the terms to be used when documenting or referencing aspects of architecture description in those standards (see Annex B).

Although the use of contemporary systems engineering practices is assumed by this part of ISO 14813, it does not define such practices.

NOTE Guidance on the use of the unified modelling language (UML) in ITS architectures can be found in ISO/TR 17452 and ISO/TR 24529. Guidance on the use of the process-orientated methodology in ITS architectures can be found in ISO/TR 26999.

2 Conformance

There are no specific conformance tests specified within or associated with this part of ISO 14183.

Developers of standards claiming conformance with this part of ISO 14183 are, however, required to describe the architecture of their system in their deliverables, or to make reference to other standards or publicly available documents that provide such description. The level of detail or the methodology used for such description is not specified and is left to the discretion of the standards developers.

Implementers of ITS cannot, of course, be required to make such provision, but are advised to do so in their plans and tender documents. This part of ISO 14813 is therefore also designed as a consistent reference for ITS system designers.

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/IEC 8824 (all parts), *Information technology — Abstract Syntax Notation One (ASN.1)*[2)]

ISO/IEC 8825 (all parts), *Information technology — ASN.1 encoding rules*[2)]

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2) ASN.1 standards are divided into the abstract syntax notation one (ASN.1) specifications and the ASN.1 encoding rules. ISO/IEC 8824-1 to ISO/IEC 8824-4 and ISO/IEC 8825-1 to ISO/IEC 8825-4 correspond to ITU-T Recommendations X.680, X.681, X.682 and X.683, and X.690, X.691, X.692 and X.693, respectively. See http://www.itu.int/ITU-T/studygroups/com17/languages/.

ISO/IEC 9834-1, *Information technology — Open Systems Interconnection — Procedures for the operation of OSI Registration Authorities: General procedures and top arcs of the International Object Identifier tree — Part 1*

ISO 14813-1, *Intelligent transport systems — Reference model architecture(s) for the ITS sector — Part 1: ITS service domains, service groups and services*

ISO/TR 14813-6, *Intelligent transport systems — Reference model architecture(s) for the ITS sector — Part 6: Data presentation in ASN.1*

ISO/IEC 19501:2005, *Information technology — Open Distributed Processing — Unified Modeling Language (UML) Version 1.4.2*

4 Terms and definitions

For the purposes of this document, the terms and definitions given in Annex B and the following apply.

4.1
ITS architecture
non-specific system design for a family of functionally different intelligent transport systems (ITS), interconnected to operate in consort and harmony

NOTE 1 An ITS architecture can be described from different viewpoints, and from multiple viewpoints by conceptual, logical and/or physical representations.

NOTE 2 An ITS architecture is not specific to any single location.

5 Requirements

5.1 General requirements

5.1.1 Architecture description

All ITS standards shall provide an *architecture description*, by inclusion in the standard or by reference to other relevant standards. The architecture description shall include information detailing the vision and mission to be achieved by applying the standard, together with a description of the architectural aspects of the standard, detailed in one of the forms specified in this part of ISO 14813. Such information may appear in either the scope or requirements clauses, as considered appropriate by the authors.

5.1.2 Service description

All architecture descriptions shall either start with, or be clearly related to, one or more of the ITS service domains, service groups and services in accordance with ISO 14813-1.

5.1.3 Architecture description elements

It is important that all ITS standards be able to be compared for inter-relationships and, consequently, this part of ISO 14813 needs to be applied to the architecture description elements of all ITS standards.

The requirements for architecture description elements are as follows.

a) **Architecture scope**

The scope of the architecture shall be described by reference to the ITS service domains, service groups and services defined in ISO 14813-1.

In implementing an application based on an ITS standard, implementers will normally also need to ensure that they are designing consistently with their organisation's enterprise architecture. Enterprise architectures do not normally form part of ITS standards.

b) **ITS system descriptions/definition**

Where schematics are included, they shall either be simply understood high-level use-case diagrams or shall be expressed in the form of process or object models.

c) **Protocol descriptions/definition**

In most cases, protocol descriptions will not be required in an architecture standard. If protocol descriptions are required, they shall be written in a widely accepted and standardised formal description language (e.g. SDL, XML, ASN.1).

d) **Data description/definition**

Data concepts, where defined, and as required by ISO 14813-6, shall be described using ASN.1 in accordance with ISO 14813-6, ISO\IEC 8824 and, where appropriate, ISO\IEC 8825.

This requirement is aimed at maximising interoperability and reuse of data. Actual data may be defined and applied using other formats, such as SDL or XML, but shall be described as an SDL, XML module within a formal ASN.1 data definition. ISO 14813-6 provides examples of how to achieve this.

There is no requirement that architecture description be elaborated in levels of detail that require data definition, and indeed this will not normally be done. However, where data definition is made, it shall be done in a way that it is consistent with the requirements of ISO 14813-6.

Where a sector already uses an existing standard notation (e.g. EDIFACT, X12), such use is permissible so long as the message content, structure and transaction elements are clearly and separably defined. Usually, this will be by reference to another standard (e.g. EDIFACT Board standard). Where attribute limitations (e.g. range of numerical values) are appropriate within the ITS standard — such as where a time/size limited air interface transaction is involved — such attribute limitations shall be specified.

5.2 Further guidance

Further guidance and assistance in the description and elaboration of systems architecture is to be found in the other parts of ISO 14813, as well as in ISO/TR 17452, ISO 19501, ISO/TR 24529, ISO 24531 and ISO/TR 26999 (see the Bibliography).

5.3 ITS architecture elements

5.3.1 General requirements

Systems architecture identifies the major actors, use cases, interfaces and components and provides a basis for understanding all their inter-relationships and interactions.

All ITS standards shall provide a description of the aspects of their architecture, either by process-oriented or object-oriented analysis, with the depth of such description varying according to the relevance to the deliverable. Where a limited standard (e.g. one determining protocols alone) is prepared, a simple statement determining its relevance in the overall architecture shall suffice.

As the name implies, an *object-oriented* architecture starts with the objects or entities that are involved in the system, characterises them and defines their relationships with other objects, entities, actors or exit interfaces, etc. A *process-oriented* methodology, conversely, starts with the processes and works towards the object/entities/actors/exit interfaces. Both approaches have their advantages and disadvantages and it is not within the remit of this part of ISO 14813 to require or prefer either.

There are some aspects and viewpoints that should, however, be considered regardless of the methodology, and at least a summary explanation of these aspects should be given in the architecture portion of any ITS standard. The documentation for each of these architecture aspects is specified below.

Architectures can, and should, be viewed from different perspectives according to the views of those parties (both human and machine) likely to be involved. An ITS architecture shall consider the following architecture aspects:

a) conceptual (or reference) architecture, starting from, and related to, one or more specific ITS service domains, service groups and services (see ISO 14813-1);

b) logical (sometimes called “functional”) architecture;

c) physical architecture;

d) communications architecture;

e) organisational architecture.

This part of ISO 14813 recognises that in general practice there could be several other viewpoints needed to fully comprehend an architectural model, and this option is available to those providing architecture description in ITS standards. What matters most is that the composite description satisfies all user and interface requirements, all non-functional requirements and that it provides a rigorous basis not only for the initial design, but also for the ongoing development of the system as it evolves and interacts in new ways with its environment.

Architectures may be described and defined in many different ways. Differing descriptive formats and notations may be used in these descriptions, but the notation that is being adopted most rapidly and widely is the unified modelling language (UML) (see ISO/IEC 19501). However, many forms of process-oriented methodology have been in use for a long period of time and are well-known and understood by many users.

This part of ISO 14813 strongly recommends, but does not require, that architecture descriptions use overview *use-case* diagrams/descriptions, with pictorial elaboration, rather than system-modelling software, to explain the context of the standard at an early stage of the architecture description in order to enable non-architecture experts to understand the scope and context of the architecture description.

The depth at which architecture considerations need to be defined in a standard, or indeed in a specification or terms of reference (TOR), will vary from a simple statement of one or two paragraphs or a figure or table, to a fully detailed specification that can be used as the basis for detailed software development. This part of ISO 14813 leaves the depth of coverage to the judgement of the standard, system or TOR developer; however, the following subclauses detail the perspectives where some description is required in an ITS standard.

5.3.2 Conceptual architecture

5.3.2.1 The clause or section of the ITS standard on conceptual architecture shall provide an overall operational description of an ITS system, incorporating operational concepts and user requirements, together with its known inter-relationships with other systems. The description of the conceptual architecture shall always use one or more of the ITS service domains, service groups and services as its starting point; or its scope shall be related clearly to assisting the fulfilment of one or more specified ITS service domains, service groups and services.

5.3.2.2 The overview shall be described by means of a vision/mission statement describing the objective result of applying the standard. The method by which they are to be achieved shall be explained.

5.3.2.3 This shall be accompanied by a simple use-case diagram/description, hierarchy chart or network diagram (e.g. reference model) and/or an overview description dealing with the overall system concepts and relationships and reference points only and, where appropriate, summarising the business case.

5.3.3 Logical architecture

A clause or section shall describe the nature of the system based on the information, control or functions and shall describe the interrelations of these aspects; the logical architecture is independent of any hardware focus or software.

A logical architecture can be described either from an object- or process-oriented perspective. Either methodology may be used at the discretion of the working group preparing the standard.

5.3.4 Physical architecture (optional)

Following the explanation of the logical architecture, this description, where provided, shall allocate, in generic terms, the logical architecture to physical entities (but not in relation to the deployment of equipment).

NOTE A physical architecture, while it describes physical configurations in system terms, is not specific to any particular location.

5.3.5 Communications architecture (optional)

Communications architecture, where provided, shall offer a high-level description of the media and medium standards and protocols used to support and communicate through the system.

5.3.6 Organisational architecture (optional)

Organisational architecture, where provided, shall identify how the organisation's(s') specific requirements are to be met. The development process shall include recognition of dependencies and boundaries for functions.

5.4 Object-oriented architecture

5.4.1 General

This clause or section in an ITS standard is relevant where object-oriented architecture description/system design is employed.

UML is being used increasingly worldwide to describe the static and dynamic logical design and behaviour of complex systems because of its *de facto* universality in describing software intensive systems in a manner that is understandable across cultures, companies and customs.

UML provides for user requirements, when encapsulated in use cases, to be related to other requirements in other use cases and also to other UML artefacts [when suitable computer-aided software engineering (CASE) tools are employed]. However, it is not necessary that use cases be expressed in UML in order for them to be meaningful and unambiguous (this is discussed in greater detail in ISO/TR 24529 and ISO/TR 17452).

UML is also useful in documenting data models as described in ISO 14817.

All architecture description is heavily dependent on the concept of abstraction. In object-oriented architecture definition, the use of abstraction is particularly important as an approach to design at every level, but especially at the architectural design level.

5.4.2 Specific requirements for object-oriented description

If an object-oriented approach is used to describe the logical architecture, it shall provide an integrated description working from the identified classes, their attributes, methods and messages and associations. In order to achieve consistency of approach and enable cross-referencing between deliverables, the object analysis symbols used shall be from the UML, as specified in ISO/IEC 19501, and shall, as far as practicable, use the UML "views" of the model that are deemed appropriate. There is, however, no requirement that UML views always be used.

5.4.3 Relationship to ITS service domains, service groups and services

In an object-oriented analysis of the architectural aspects of an ITS standard, the highest-level (abstract) "classes" described shall always be related to the provision of one or more specified ITS service domains, service groups and services, as defined in ISO 14813-1.

5.4.4 Control behaviour

Control behaviour describes changes of ITS architecture elements from one state to another.

5.4.5 Multiple viewpoints

The need for multiple viewpoints in architecture models has been widely recognised and an object-oriented architecture shall describe multiple views. The appropriateness of particular viewpoints is left to the discretion of the developer of the deliverable.

5.5 Process-oriented architecture

5.5.1 General

A process-oriented (functional) decomposition of the logical architecture is represented by functional, control and information architectures. If a process-oriented approach is used, the requirements defined in 5.5.2 shall be provided.

There are three basic types of process-oriented methodology for ITS architecture:

a) framework;

b) defined;

c) specific.

The principal differences between these approaches depends on

— the viewpoints created,

— the "outputs" produced, and

— how these viewpoints and outputs are used.

5.5.2 Specific requirements for process-oriented methodology description

5.5.2.1 Context

The following clauses or sections are relevant where process-oriented architecture is employed.