

WITHDRAWN

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IEEE Standard for Message Set Template for Intelligent Transportation Systems

Sponsor

IEEE Standards Coordinating Committee 32
on
Intelligent Transportation Systems

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IEEE-SA Standards Board

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Abstract: The expanding use of digital communications among subsystems of the transportation infrastructure has spawned the development of message sets for the communications between these subsystems. A format for Intelligent Transportation System (ITS) message sets, including common terms (E.g., object identifier), as well as attributes necessary to document ITS data messages, is addressed in this standard.

Keywords: attribute, data concept, data element, "dataelement," data frames, "dataframe," intelligent transportation systems, message, message set, meta-attribute, template, transportation

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Introduction

(This introduction is not part of IEEE Std 1488-2000, IEEE Standard for Message Set Template for Intelligent Transportation Systems.)

At the 1996 Intelligent Transportation Systems (ITS) America Annual Meeting, a survey was taken to determine what ITS standards were in need of development. Among the highest priorities of the ITS America membership and the Standards Developing Organizations' membership were message sets and an ITS Message Set Template Standard. The Federal Highway Administration (FHWA) Joint Program Office for ITS established a "Cooperative Agreement" with IEEE to expedite the development of ITS standards by supplementing the voluntary committee efforts with funding to hire subject matter technical experts.

IEEE Standards Coordinating Committee 32 (SCC 32) formed a working group to develop this ITS message standard and a complementary data dictionary standard. The working group first met in November 1996, at IEEE headquarters in Piscataway, N.J.. Significantly, the first item of business was to define the goal of the working group and the standards they were to develop. This goal was articulated as the unambiguous interchange and reuse of data and information between the various ITS functional subsystems.

This standard presents a uniform set of attributes used to define messages and other data concepts to be used in transferring information among various ITS functional areas and systems. It further establishes uniform methods of identifying the messages and defining specific requirements for the messages that typically would be handled by the communications application program above the ISO OSI application layer.

This standard does not establish an underlying communication standard, techniques for encoding the information, or any lower-level protocols.

Committee Membership

At the time this standard was completed, the working group on ITS Data Dictionary and Message Sets for Intelligent Transportation Systems had the following membership:

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The working group was ably assisted by Tony Sarris, a technical consultant/subject material expert who guided the group through its early wanderings, provided numerous examples and ideas as to what a message set template standard could be, and, finally, did most of the work in drafting the standard. Also, thanks to Burt Parker for his help in ensuring that the ITS data dictionary standard and data registry were properly coordinated with the Message Set Template (MST).

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IEEE Standard for Message Set Template for Intelligent Transportation Systems

1. Overview

1.1 Scope

This standard specifies attributes for documenting messages used to transfer information between computer-based Intelligent Transportation Systems (ITS)-compatible applications. For example, this standard requires each message to have a unique identifier. In general, this standard reflects the perspective of messaging from an end-application standpoint. It supports specification of logical messages. While end-application messages may drive requirements that will be met through services provided by various communications protocols and networks, this standard is concerned only with the logical specification of such data exchange requirements. This standard does not address the specification of any particular messages within any ITS functional area or application domain. This standard does not define any physical implementations of messages, nor does it define any particular uses or configurations of communications protocols and networks.

1.2 Purpose

The purpose of this standard is to specify a format for defining and documenting ITS messages, independent of their implementation. The format defined within this document is intended for those messages that are used to exchange ITS information between applications; other formats may be more appropriate for command, control, and monitoring functions of the communications and device network. This standard is to be used by persons (e.g., information technology professionals and transportation engineers) for the purpose of logically specifying ITS messages.

2. References

The following documents shall be used when applying this standard, particularly for understanding how the contents of ITS data dictionaries are to be used when specifying the body of a message. When the following documents are superseded by an approved revision, the revision shall be reviewed for applicability.

IEEE Std 1489-1999, IEEE Standard for Data Dictionaries for Intelligent Transportation Systems.¹

¹IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA (<http://standards.ieee.org/>).

ISO/PRF TR 14813-6, Transport Information and Control Systems—(TICS) Reference Model Architecture(s) for the TICS Sector—Part 6: Data Presentation in ASN.1.²

ISO/IEC 8824-1:1998, Information technology—Abstract Syntax Notation One (ASN.1): Specification of Basic Notation.³

ISO/IEC 8824-2:1998, Information technology—Abstract Syntax Notation One (ASN.1): Information Object Specification.

ISO/IEC 9834.1:1993, Information technology—Open Systems Interconnection—Procedures for the operation of OSI Registration Authorities: General procedures.

3. Definitions, terminology, abbreviations, and acronyms

For the purposes of this standard, the following terms, definitions, abbreviations, and acronyms apply. For terms not defined in this clause, English words are used in accordance with their definitions in the latest edition of *Webster's New Collegiate Dictionary* [B5].⁴ Electrical and electronic terms not defined in this clause or in *Webster's New Collegiate Dictionary* [B5] are used in accordance with their definitions in The IEEE Standard Dictionary of Electrical and Electronics Terms [B4].

3.1 Terminology

3.1.1 attribute: an inherent characteristic of an item ascribing an inherent quality.

3.1.2 data frame: A grouping of data elements primarily for the purpose of referring to the group with a single name, and thereby efficiently reusing groups of data elements that commonly appear together (as an ASN.1 Sequence, Sequence Of, Set, Set Of, or Choice) in a message body specification. This data concept type may, however, be used to specify groups of data elements for other purposes as well.

3.1.3 end-application: The portion of a computer program that is separate from the communications stack. Specifically, an end-application does not include the Application Layer of the OSI Reference Model, nor any of the layers below that.

3.1.4 foreign data source: A data dictionary or message set developed by a non-Intelligent Transportation Systems (ITS) community. A data concept not defined in accordance with IEEE Std 1489-1999.⁵

3.1.5 message: A grouping of data elements and/or data frames, as well as associated message metadata, that is used to convey a complete unit of information. For the purposes of this document, a message is an abstract description using a message set template (MST); it is not a specific instance.

NOTE—Some standards refer to this as an *end-application message*.

²ISO publications are available from the ISO Central Secretariat, Case Postale 56, 1 rue de Varembé, CH-1211, Genève 20, Switzerland/Suisse (<http://www.iso.ch/>). ISO publications are also available in the United States from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA (<http://www.ansi.org/>).

³IEC publications are available from the Sales Department of the International Electrotechnical Commission, Case Postale 131, 3, rue de Varembé, CH-1211, Genève 20, Switzerland/Suisse (<http://www.iec.ch/>). IEC publications are also available in the United States from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA (<http://www.ansi.org/>).

⁴The numbers in brackets correspond to those of the bibliography in Annex D.

⁵Information on references can be found in Clause 2.

3.1.6 message attribute: Information that describes a message and which may specify, at the logical level, relevant associated requirements for data exchange, interpretation, and handling.

3.1.7 message body: That portion of a message specification that describes the data elements and/or data frames contained within the message.

3.1.8 message group: A collection of related messages.

3.1.9 message instance: An occurrence of a message containing the actual values for the data elements and, in some cases, data about the message.

3.1.10 message set: A collection of messages based on the ITS class names.

3.1.11 message set template (MST): An abstract structure addressing the message attributes and syntax used to specify ITS messages, as well as rules for producing message standards using the MST (e.g., conformance statements).

3.2 Abbreviations and acronyms

Some of the following abbreviations and acronyms are from SAE J1761:1995 [B3].

ASN.1	abstract syntax notation one
ATIS	advanced traveler information system
ATMS	advanced traffic management system
DSRC	dedicated short-range communications
IANA	Internet Assigned Numbers Authority
ID	identifier
IOS	information object specification
ISP	information service provider
ITS	intelligent transportation system(s)
MST	message set template
NTCIP	national transportation communications for ITS protocol
OID	object identifier
OSI	open system interconnection
TMC	traffic management center

4. Message Set Template (MST) framework

4.1 Role of MST in ITS information interchange

In order to accomplish the unambiguous interchange of information among complex systems, there must be a common understanding of

- a) The data elements, and possibly other data concepts, to be exchanged
- b) The requirements for exchanging the data

IEEE Std 1489-1999 specifies a mechanism to unambiguously define and standardize the data elements and any other data concepts that may be exchanged. Since data elements (including groupings of data elements into data frames) comprise the typical contents in a message, the term *data element* is used from this point forward to reference all such components within a message, except when otherwise noted, to avoid undue repetitiveness.

This standard similarly specifies a mechanism to unambiguously define and standardize the logical requirement for exchanging data among ITS systems. Other standards specify how these logical requirements are implemented in various communications environments (as per the ISO OSI 7-Layer Architecture—refer to ISO/IEC 7498:1990 [B1]). Thus, messages defined according to this standard are as independent as possible from the mechanisms used to physically exchange the data. These logical messages only specify the data exchanged between applications, as well as other high-level requirements of the exchange. In conjunction with IEEE Std 1489-1999 compliant data dictionaries, they provide an unambiguous definition of what specific data exchanges mean.

Interoperability, however, is only obtained when these messages are implemented according to the rules defined for the various implementation environments. It is assumed that if a single logical message is to be implemented by more than one protocol (including cases where a message is handed off from one messaging environment to another), the responsible parties involved in the message specification and implementation efforts will coordinate to ensure that there is interoperation at the protocol level, as necessary. Figure 1 depicts an ITS message and is expanded to highlight the components of the entire message and the clauses of this document that define the attributes for a message and its components. The message is defined using the IEEE Std 1489-1999 basic and administrative meta-attributes, as described in 5.2 of this standard. The message body is defined in 4.5.2. Mandatory message attributes and optional message attributes are defined in 5.1 and 5.3, respectively. Extended message attributes are defined throughout Clause 5.

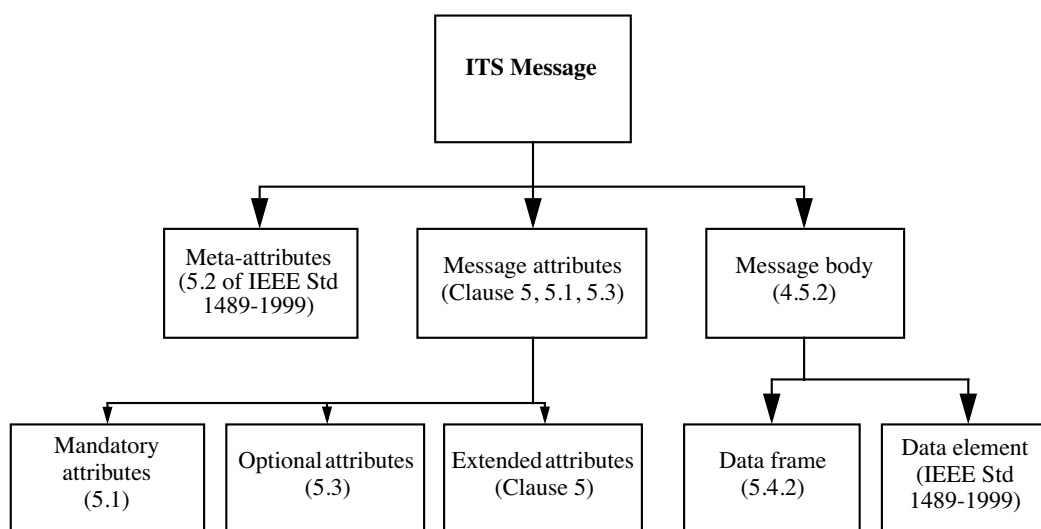


Figure 1—ITS Messages

4.2 The nature of ITS messages

ITS messages cover a broad spectrum of uses and vary considerably in their timing, form, and implementation environment. For example, messages may be

- Wireline versus wireless
- Real-time versus transactional
- Bandwidth-constrained versus (relatively) unconstrained
- Broadcast versus directed (e.g., point-to-point)
- Short-range via radio frequency versus (relatively) long-distance routing via a network

Most messages depend directly upon ITS data dictionaries and/or the ITS data registry for description of the data elements in the message; however, other messages may make indirect reference to other (foreign) sources of metadata about data elements, or embed data element metadata as part of the message instance.

NOTE—Data concepts (data elements, messages, etc.) that originate in foreign data dictionaries may be introduced to the ITS standardization process through a relevant ITS functional-area data dictionary.

Within each functional area there are many messages used for interchanging information with other applications in that same functional area and with other functional areas. An ITS message may be categorized into one or more message groups based on some criteria such as the nature of the subject matter of the message. A message may be part of more than one message group. For example, the “Disabled Vehicle” message might be part of the message group “Roadside Alerts,” as well as the message group “Vehicle Events.” Within a functional area, a message is also specified as being part of one or more message sets. In this case, the message set might be “Traffic Management.”

The ITS MST is intended as a uniform, canonical specification template for all relevant ITS messages, regardless of their nature. Given this objective, coupled with the wide disparity in the nature of messages, many aspects of the MST have been made optional.

4.3 Positioning the ITS MST relative to the ISO OSI 7-layer architecture

The Open System Interconnection (OSI) model developed by The International Organization for Standardization (ISO) (ISO/IEC 7498:1990 [B1]) identifies seven layers for organizing any implementation of a messaging or communications environment and managing its services. Each higher level requests a service which is provided by the next lower layer in the architecture. The seven layers are:

- Layer 7—Application: application interface
- Layer 6—Presentation: presentation to applications
- Layer 5—Session: presentation dialog management
- Layer 4—Transport: message handling
- Layer 3—Network: routing of packets
- Layer 2—Data link: frames from node to node (with shielding)
- Layer 1—Physical: bits on a wire.

The MST specifies messages at a logical, implementation-independent level. This logical level sits above the seven layers of OSI. Some standards refer to this as the end-application.

4.4 Overview of the MST

The MST defined by this standard shall be used for specifying all relevant ITS messages (as described in 4.2), while taking into account the wide disparity in the nature of ITS messages. Having one MST is necessary to ensure that, at a minimum, there is some common method and format for specifying all relevant ITS messages. The MST shall consist of specification of metadata about the message, including any data exchange requirements associated with the message, as well as specification of the message body (i.e., a description of the data elements contained in the message). These shall be expressed using abstract syntax notation one (ASN.1) syntax. An ASN.1 information object specification (IOS) shall be used to combine the specification of the message attributes and the message body into a complete formal specification of the logical message. (See Annex B.)

Because of the variety of messages, the number of MST attributes that are mandatory for all messages is minimal. The primary mandatory attribute is a unique message identifier, specifically an ASN.1 Object Identifier. Having a unique message identifier ensures that every application encountering an ITS message instance in any implementation medium is provided a means for determining whether that message instance

is of interest to the given application. Other message metadata consists of additional attributes that may be used for documentation of an ITS message. For documentation purposes, the attributes that comprise the message specification shall appear in the order in which they are specified in Table 1.

4.5 Applying the MST for specifying messages

The MST serves as a standard means for logically specifying ITS messages. That specification encompasses two distinct aspects, which are described in 4.5.1 and 4.5.2.

4.5.1 Specifying metadata about the message

The first aspect of the MST addresses message metadata. Metadata is simply data about the message being specified. This standard contains the set of mandatory and optional attributes that shall be used to specify message metadata; for example, to describe the nature of the message and the data exchange requirements that the message places on its application and/or messaging environment. Most of these attributes serve a purely documentation-related purpose; i.e., the metadata about the message shall be used by in-house developers and/or vendors during development and implementation of applications and their associated messaging environments. Some of the metadata may be utilized directly or indirectly as part of the message implementation, but such usage is not specified in the MST.

When requirements for applications and/or messaging environments to support a message are specified using the MST, the requirements shall be specified at the logical level. The requirements shall be expressed in a media-neutral manner. Some requirements may apply to an application system; others may be viewed as requests for services to be provided at one or more of the OSI 7 layers. How a given requirement is met is an implementation issue that is outside the scope of the MST standard.

4.5.2 Specifying the message body

The second aspect of the MST addresses the abstract specification of the message body or contents. When specifying a message, the contents of that message shall be specified by elaborating which data elements (including data frames composed of groups of data elements, and, in some cases, other data concept types) are grouped or packaged into which messages, under what conditions, and, where applicable, in what order. The instantiation of these data elements shall comprise the actual message body for a message instance. The specifications shall be expressed in ASN.1 syntax as per ISO/IEC 8824-1:1998 and ISO/IEC 8824-2:1998. The specifications shall use only the data elements, data frames composed of data elements, and, in some cases, other data concept types, specified in ITS data dictionaries. Exceptions are made for data elements found in foreign data dictionaries (handled indirectly, by reference), as well as those cases where metadata is embedded in the instance of the message (handled by noting that there will be embedded metadata).

The data elements and data frames comprising a message body shall be specified using an ASN.1 Name (i.e., a name conforming to the ASN.1 naming conventions). The Descriptive Name of a data element may optionally be included in addition to its ASN.1 Name, as part of the message specification. In such cases, each Descriptive Name shall be paired with its corresponding ASN.1 Name. Annex B includes a guideline for converting IEEE Std 1489-1999 compliant Descriptive Names to ASN.1 Names.

The packaging or grouping of data concepts (data elements, data frames, and/or other data concept types) into messages may involve specifying any or all of the following:

- The data concepts comprising the message body, including their ordering or sequence, where applicable.
- Repeatability of data concepts within a sequence, or of segments of sequences, comprising the message body.
- Optionality, default values, and conditionality (i.e., dependency) among data concepts comprising the message body.

NOTES:

1—Repeating sequences of data concepts are allowed as part of a message specification.

2—Message specifications that use only data elements (which are low-level data concepts considered atomic in some context for some purpose) avoid ambiguity. However, more complex data structures can be specified in a message by building up groups of data elements using the Sequence and Set syntax of ASN.1. Commonly occurring sequences or other groupings of data elements may be handled through the use of the “data frame” data concept type (refer to 4.5.3 for more specific details).

For cases where the metadata source is direct from an ITS functional-area data dictionary or the ITS data registry, a message specification shall contain data frames (see 4.5.2) and data elements that are explicitly represented in an ITS functional-area data dictionary and/or the ITS data registry.

Permissible ranges of values, lists of values for enumerated types, or rules for determining valid values for the value domains of data elements are specified for the data elements as part of the metadata about them in an ITS functional-area data dictionary and/or the ITS data registry.

Data types and size-related constraints are specified for the data elements as part of the metadata about them in an ITS functional-area data dictionary and/or the ITS data registry.

Any metadata related to data elements in a message specification that is in addition to the information in an ITS functional-area data dictionary and/or the ITS data registry should be maintained in coordination with the data dictionary and/or registry to ensure consistency.

4.5.3 Use of ASN.1 syntax

The syntactical constructs of ASN.1 (ISO/IEC 8824-1:1998 and ISO/IEC 8824-2:1998) shall be used to specify the message attributes and the data elements that comprise the message body. The statements formed by the use of the ASN.1 constructs listed in ISO/IEC 8824-1:1998 and ISO/IEC 8824-2:1998, in accordance with ASN.1 syntax rules, shall be valid ASN.1 productions.

Annex B further describes these ASN.1 constructs and provides some examples of their use. However, any other valid constructs of ASN.1 may also be used for message specification.

4.5.4 Packaging the message specification in an ASN.1 IOS

An ASN.1 information object is a syntactic mechanism that shall be used for grouping the specification of the message attributes and message body into a single entity. Annex B provides templates and examples of MST-conformant IOSs. Packaging of the message specification in such a form facilitates ITS message specifications produced for one message domain being exchanged with and interpreted by other ITS message domains.

4.6 Relationship between message specifications and the ITS data registry

Messages, as well as data frames (where utilized), shall be described as data concepts (see IEEE Std 1489-1999) and may be managed in the ITS data registry.⁶ Part of the data registry serves as a logical message catalog; there is functionality provided to specify messages (i.e., both the attributes that describe information about a message and the message body), as well as data frames. Wherever possible and applicable, the same meta-attributes are utilized for messages and data frames as for other data concepts contained in the data registry. The primary difference is that many of these are optional for messages, and some additional

⁶The Institute of Electrical and Electronics Engineers is the Data Registrar for the Intelligent Transportation System Data Registry. Additional information on the ITS Data Registry is available from the IEEE.