

IEEE Standard for Data Dictionaries for Intelligent Transportation Systems

Sponsor

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on
Intelligent Transportation Systems**

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Abstract: The expanding use of digital communications among subsystems of the transportation infrastructure has spawned the development of data dictionaries for the communications between these subsystems. A format for Intelligent Transportation System (ITS) data dictionaries, including common terms (e.g., time, date, location), as well as meta-attributes necessary to document ITS data concepts is addressed in this standard.

Keywords: attribute, classification scheme, data dictionary, data element, data element concept, functional-area data dictionary, entity, entity type, generic property domain, information interchange, intelligent transportation systems, ISO/IEC 11179, meta-attribute, metadata standard, value domain

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Introduction

(This introduction is not part of IEEE Std 1489-1999, IEEE Standard for Data Dictionaries for Intelligent Transportation Systems.)

At the 1996 Intelligent Transportation Systems (ITS) America Annual Meeting, a survey was taken to determine ITS standards needs. Among the highest priorities of the ITS America membership and the other standards developing organizations' membership were data dictionaries and an ITS data dictionary standard. The Federal Highway Administration (FHWA) Joint Program Office for ITS established a "cooperative agreement" with the IEEE to expedite the development of ITS standards by supplementing the voluntary committee efforts with funding to hire subject matter technical experts. ITS America formed a Data Dictionary Task Force, composed of functional-area data dictionary working group leaders, to define the general requirements for a data dictionary standard. The result is a standard based on ISO/IEC 11179 (see [B21]–[B26])¹, with mandatory attributes that will facilitate interchange of data between ITS functional areas.

IEEE Standards Coordinating Committee 32 (SCC 32) formed a working group to develop this ITS data dictionary standard and a complementary message 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 it was to develop. This goal was articulated as the unambiguous interchange and reuse of data and information between the various ITS functional subsystems. It was recognized that ISO/IEC 11179 (see [B21]–[B26]) forms a basis for the data elements, but that additional efforts beyond ISO/IEC 11179 (see [B21]–[B26]) were required to achieve the goal of unambiguous data interchange.

The working group realized that this standard alone would not achieve the goal of unambiguous interchange and reuse of data among functional areas of ITS. The working group defined the requirements for an ITS data registry as a particular kind of data dictionary. The ITS data registry is to be a logically centralized repository for all ITS data elements and other data concepts that have been formally specified and established for use within the ITS domain. The purpose of the ITS data registry is to support the unambiguous definition and reuse of data among functional-areas of ITS (i.e., among associated ITS subsystems and their application systems). Other standards define how the contents of a data registry are unambiguously interchanged. The ITS data registry is addressed by part 2 of this standard. The additional effort of establishing and operating an ITS data registry is out of the scope of this working group.

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

Valerie Shuman, *Chair*

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Thomas M. Kurihara
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The working group extends a special thanks to Bancroft Scott. His generous contribution of time spent and technical knowledge shared over different meetings of the working group (and numerous messages) vastly increased our understanding of ASN.1 syntax, and helped realize our goal of unambiguous data interchange between ITS functional subsystems.

The working group was ably assisted by two technical consultants/subject material experts, Burt Parker and Tony Sarris, who guided the group through its early wanderings, provided numerous examples and ideas as

¹The numbers in brackets correspond to those of the bibliography in Annex E.

to what a data dictionary standard could be, and, finally, did most of the work in drafting the standard.

We also acknowledge the contributions of Charlie Herget and Ivor Knight, who served as program and project managers under contract to IEEE. Their knowledge of standards, and the IEEE system of developing standards, helped to keep the group on track and productive.

Finally, we thank the following IEEE staff members who helped both with the administrative matters of producing a standard, as well as often making technical and editorial contributions: Rosemary Tennis, Tricia Gerdon, Lisa Young, and Jerry Walker.

The following members of the balloting committee voted on this standard:

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IEEE Standard for Data Dictionaries for Intelligent Transportation Systems

1. Overview

1.1 Scope

This standard addresses the concepts of data dictionaries as applied to Intelligent Transportation Systems (ITS), an underlying framework to support the concepts, and the set of data concepts and meta-attributes used to describe, standardize, and manage the contents of such data dictionaries. Various annexes also provide specifications for ITS naming requirements; standard ITS value domains and representation class terms; and a classification scheme for organizing ITS data dictionary contents.

1.2 Purpose

This standard is intended for use by both developers and users of ITS data dictionaries. This standard specifies a common set of data concepts and meta-attributes for ITS data dictionaries, as well as associated conventions and schemes that enable the description, standardization, and management of all ITS data. Through consistent use (in conformance with this standard) of these common structures and associated conventions and schemes, data and information can be unambiguously defined. Other ITS standards define issues such as how data elements are combined into messages and how messages are exchanged over specific communications interfaces, what groups of data should coexist within a given system, and the requirements for an ITS data registry. Through the implementation of this entire family of standards, data can be unambiguously interchanged and reused among the various ITS functional subsystems via their specific application systems.

2. References

The following documents shall be used, when applicable, in the process of developing, populating, using, and managing an ITS data dictionary. When the following documents are superseded by an approved revision, the revision shall apply.

IEEE Std 100-1996, IEEE Standard Dictionary of Electrical and Electronics Terms, Sixth Edition.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/IEC FDIS 8824-1, Information technology—Abstract Syntax Notation One (ASN.1): Specification of basic notation (2nd Edition), 20 September 1999.²

3. Definitions, acronyms, and abbreviations

For the purposes of this standard, the following terms, definitions, acronyms, and abbreviations 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* [B29]³. Electrical and electronic terms not defined in this clause, or in *Webster's New Collegiate Dictionary* [B29], are used in accordance with their definitions in IEEE Std 100-1996.⁴

3.1 Definitions

3.1.1 application-specific data dictionary: A data dictionary specific to a particular implementation of an ITS application.

3.1.2 attribute: A documenting characteristic of an entity.

3.1.3 classification scheme: A scheme for the arrangement or division of entities into groups based on properties that the entities have in common.

3.1.4 concept: A unit of thought constituted through abstraction on the basis of characteristics common to a group of entities.

3.1.5 data: Representations of static or dynamic entities in a formalized manner suitable for communication, interpretation, or processing by humans or by machines.

3.1.6 data concept: Any of a group of data dictionary structures defined in this standard (e.g., data element, data element concept, entity type, property, value domain, and generic property domain) referring to abstractions or things in the natural world that can be identified with explicit boundaries and meaning, and whose properties and behavior all follow the same rules.

3.1.7 data dictionary: An information technology for documenting, storing, and retrieving the syntactical form (i.e., representational form) and some semantics of data elements and other data concepts.

3.1.8 data element: A syntactically formal representation of some single unit of information of interest (such as a fact, proposition, or observation), with a singular instance value at any point in time, about some entity of interest (e.g., a person, place, process, property, object, concept, association, state, event). A data element is considered indivisible in a certain context.

NOTE—An example of a data element is “ROUTE.BUS_Stop_location”.

3.1.9 data element concept: An expression of the inherent concept embodied in a data element without regard to the value domain(s) by which it can be physically represented.

NOTE—An example of a data element concept is “ROUTE.BUS_Stop”.

²ISO/IEC draft publications are available from the ISO Central Secretariat, Case Postale 56, 1 rue de Varembe, 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>).

³The numbers in brackets correspond to those of the bibliography in Annex E.

⁴Information on references can be found in Clause 2.

3.1.10 data registry: A data dictionary that contains not only data about data elements in terms of their names, representational forms, and usage in applications, but also substantial data about the semantics or meaning associated with the data elements as concepts that describe or provide information about real or abstract entities. A data registry may contain abstract data concepts that do not get directly represented as data elements in any application system, but that help in information interchange and reuse both from the perspective of human users and for machine interpretation of data elements.

3.1.11 data type: A classification of the collection of letters, digits, and/or symbols used to encode values of a data element based upon the operations that can be performed on the data element.

NOTE—An example of a data type is Integer Type (as defined in ISO/IEC FDIS 8824-1, 20 September 1999).

3.1.12 entity: Anything of interest (such as a person, place, process, property, object, concept, association, state, or event) within a given domain of discourse (in this case, within the ITS domain of discourse).

3.1.13 entity type: The construct used to represent an entity in Intelligent Transportation Systems (ITS) data dictionaries.

3.1.14 foreign data dictionary: A data dictionary developed by a non-Intelligent Transportation Systems (ITS) community.

3.1.15 functional-area data dictionary: A data dictionary that standardizes data element syntax and semantics, within and among application areas within the same functional area.

NOTE—Functional-area data dictionaries contain among their contents refined or synthesized composites of the contents of application-specific data dictionaries, primarily in the form of logical application data elements.

3.1.16 generic property domain: An expression of a pairing of a property and a value domain, without regard to any entity type with which it may be associated.

NOTE—An example of a generic property domain is “Stop_location”.

3.1.17 identifier: A means of designating or referring to a specific entity instance.

3.1.18 instance: An individual occurrence of an entity that belongs to a particular type of entity.

3.1.19 meta: A word denoting a description that is one level of abstraction above the entity being described.

3.1.20 meta-attribute: A documenting characteristic of a data concept.

3.1.21 metadata: Data that defines and describes other data.

3.1.22 name: An indexical term used by humans as a means of identifying data elements and other data concepts.

3.1.23 property: A documenting characteristic of an entity type used to group and differentiate individual entities.

NOTE—An example of a property is “Stop”. This property might be associated with the entity types “ROUTE.BUS” and “ROUTE.TRAVELER”.

3.1.24 semantics: The meaning, including concept(s), associated with a given entity.

3.1.25 syntax: The structure of expressions in a language and the rules governing the structure of a language.

3.1.26 value domain: An expression of a specific and explicit representational value of some information about something of interest within the Intelligent Transportation Systems (ITS) domain.

NOTE—An example of a value domain is numbers as applied to freeway lanes, which have Integer Type as their data type and a Valid Value Rule expressing the range 1–99.

3.1.27 ::= : ASN.1 TypeAssignment. The ASN.1 “assignment item.” It states that the item on the left of the ::= is given the definition on the right of the ::=.

3.2 Acronyms and abbreviations

Many of the following abbreviations and acronyms are from SAE J1761-1995 [B27].

ASC	actuated signal controller
ATMS	advanced traffic management system
AVI	automated vehicle identification
AVL	automated vehicle location
CASE	computer-aided software engineering
CVISN	commercial vehicle information systems and networks
CVO	commercial vehicle operations
DBMS	database management system
DMS	dynamic message sign
DSRC	dedicated short range communications
E911	enhanced 911
EDI	electronic data interchange
EMS	emergency management system or emergency medical services (i.e., ambulance response teams)
EPA	Environmental Protection Agency
ETTM	electronic toll and traffic management
GIS	geographic information system
HAR	highway advisory radio
ID	identification
ISP	information service provider
ITS	intelligent transportation system(s)
TMC	traffic management center
TMDD	(advanced) traffic management (system) data dictionary
TMS	traffic management system
TRS	transit management system

4. A framework for ITS data dictionaries

4.1 Basic concepts for ITS data dictionaries

4.1.1 Definition of a data element

A data element is a formalized representation of some information (such as a fact, a proposition, an observation, etc.) about some concrete or abstract thing—an entity—such as a person, place, process, object, concept, association, state, or event. A data element (a data concept) shall be a composite of three data concepts (see Figure 1): entity type, property, and an explicit representation class term (and value domain reference, where applicable, describing the physical form of the information). In Figure 1, the data element illustrated is “ROUTE.BUS_Stop_location”.

Data elements comprise the basic contents of data dictionaries.

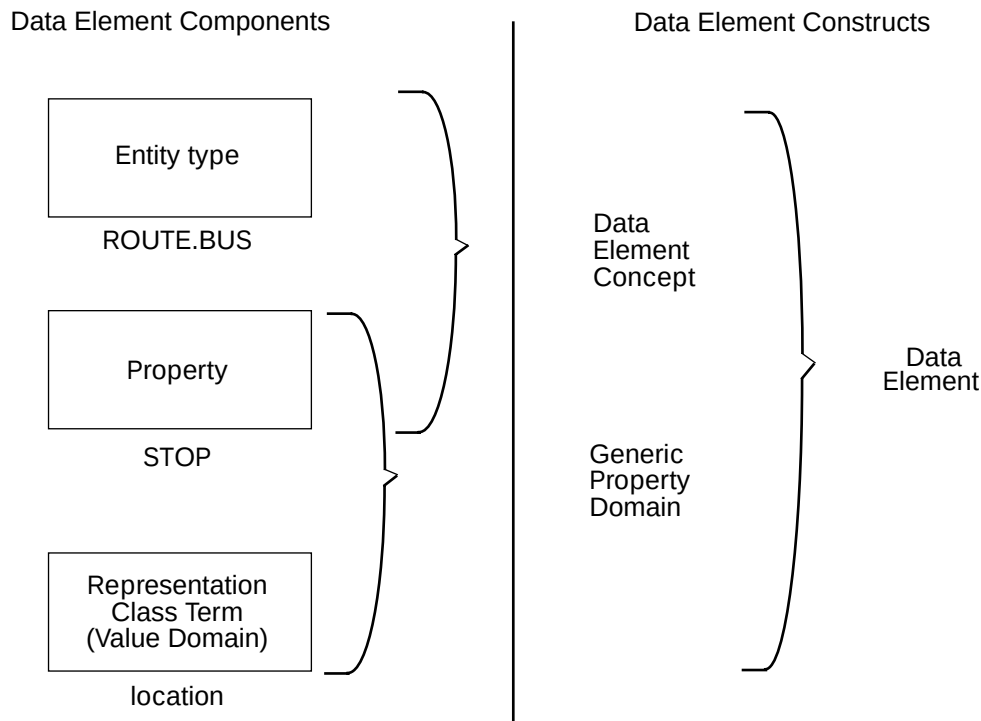


Figure 1—Data concept components and constructs

Imported data elements (from foreign applications) shall be transformed to conform with this standard.

4.1.2 Kinds of data dictionaries and their relationships

For purposes of this standard, three kinds of data dictionaries are identified. These are depicted in Figure 2, and described in detail in Clause 4. The differences in the data dictionaries relate to the breadth and depth of their contents, to the numbers and formality of meta-attributes they use to describe their contents, and the level and degree of data management and control exercised by each kind. The technical differences are driven by differences in the intended purposes and uses of the data dictionaries.

4.1.2.1 Application-specific data dictionaries

An application-specific data dictionary shall contain the data elements used by an ITS application in its physical operational environment, as well as for interchange with other applications. For example, a traffic signal control system within the traffic management functional area might have its own data element names, representational formats, and so forth within its specific application context. These data dictionaries define at least a minimal set of meta-attributes for data elements.

NOTE—Data elements that originate in foreign data dictionaries may be introduced to the ITS standardization process through a relevant ITS application-specific data dictionary.

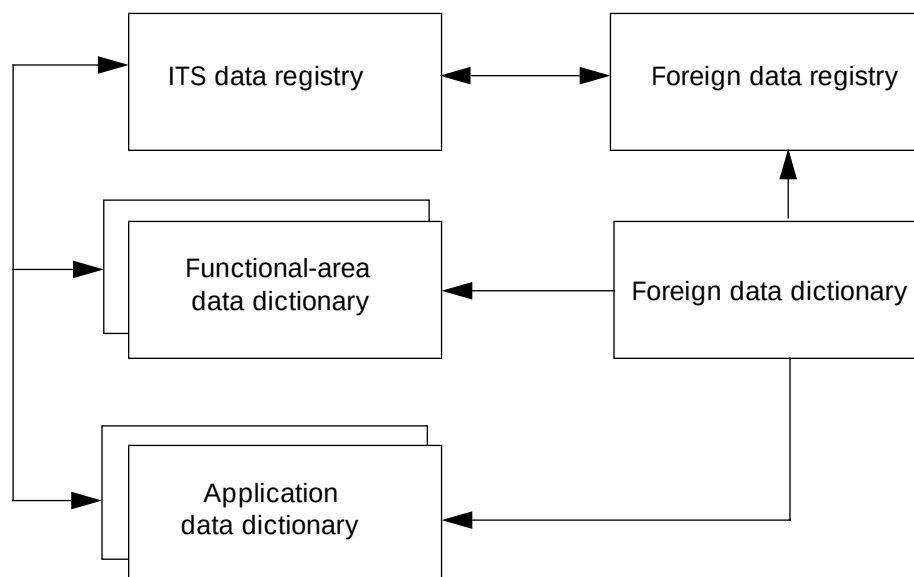


Figure 2—Information flow

4.1.2.2 Functional-area data dictionaries

A functional-area data dictionary shall standardize data element syntax, and, to a lesser degree, semantics, among applications within a given functional area (e.g., transit management or traffic management). The functional-area data dictionaries are refined composites of the contents of the application-specific data dictionaries. Other kinds of contents, such as data element concept specifications and specifications of entity types may also be included. The functional-area data dictionaries require the complete set of mandatory meta-attributes for data elements as specified in this standard.

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

4.1.2.3 ITS data registry

The ITS data registry⁵ is a logically centralized repository for all ITS data elements and other data concepts that have been formally specified and established for use within the ITS domain. The ITS data registry is a common or shared data reference for the ITS domain. The purpose of the ITS data registry is to support the unambiguous interchange and reuse of data and data concepts among functional areas of ITS (i.e., among associated ITS subsystems and their application systems) by recording unambiguous definitions of data concepts.

The ITS data registry includes the composite of all data elements and any other data concepts that are the subject of the various functional-area data dictionaries, as well as any general data concepts that span a number of ITS functional areas. The data registry contains mappings to contents in functional-area data dictionaries, and, in some cases, to application-specific data dictionaries. The contents of the data registry are subjected to rigorous registration and configuration management procedures that ensure quality and

⁵The 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.

integrity of its contents. Application-area data dictionaries may find it useful to adopt and reuse data concepts from the data registry.

Figure 2 depicts the interchange of information (i.e., data concepts)

- Between the data registry, functional-area data dictionaries, and application-area dictionaries;
- In the flow of information from application-specific data dictionaries up through the functional-area data dictionaries to the data registry; the inclusion of foreign data elements in ITS data dictionaries; and
- In the coordination between the ITS data registry and a foreign data registry.

5. Meta-attributes for ITS data dictionaries

This clause provides the formal specification of all ITS data dictionary meta-attributes required for ITS data concepts. These are consistent with, but go beyond, those in ISO/IEC 11179 (see [B21]–[B26]). Table 1, which appears in 5.1.2, and Table 2, which is shown in 5.2.2, denote which meta-attributes (e.g., Descriptive Name) apply to which data concepts (e.g., data elements, data element concepts, entity types, properties, value domains).

The specifications in this clause address meta-attributes appropriate for functional-area data dictionaries. For each meta-attribute, there is a formal definition plus optional descriptive text of a non-normative, explanatory nature, and non-normative examples (where necessary or useful). After the definitions for each grouping, there is a summary table of the meta-attributes mapped to the data concept(s) to which they apply, along with notation of whether they are mandatory, optional, indicative, or contingent.

5.1 Basic meta-attributes for functional-area data dictionaries

These meta-attributes are the basic descriptive meta-attributes for documenting all ITS data concepts at the functional-area data dictionary level. The table of applicable meta-attributes for each data concept is in 5.1.2.

5.1.1 Specification of basic meta-attributes

5.1.1.1 Descriptive name

Definition: A descriptive word or group of words that labels a data concept.

Description: Descriptive names represent the meaning of the data concept and facilitate semantic understanding. Descriptive names shall be constructed in accordance with Annex A.

Example: “EVENT_ResponsePlanType_code”

5.1.1.2 Descriptive name context

Definition: A designation of the ITS functional-area within which the descriptive name is relevant.

Description: Legal values for this meta-attribute are the names of the ITS National Architecture functional-areas as follows: Manage Traffic, Manage Transit, Manage Emergency Services, Manage Commercial Vehicles, Provide Driver and Traveler Services, Provide Electronic Payment, Provide Vehicle Monitoring and Control, and Plan System Deployment and Implementation. If more than one applies, specify “ITS” as the descriptive name context.