INTERNATIONAL STANDARD

ISO
22837

First edition
2009-01-15

Vehicle probe data for wide area communications

Données de sonde du véhicule pour les communications de surfaces étendues

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9979-3357d1a790df/iso-22837-2009

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Foreword

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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 22837 was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems*.

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Introduction

This International Standard specifies the core and initial sets of probe data elements and example probe messages, and a framework for defining and extending these probe data elements and probe messages. It facilitates the development and operation of probe vehicle systems by providing a standard set of probe data elements and probe messages along with the basic data framework to extend the set.

This International Standard provides a reference architecture for probe vehicle systems and for probe data, a basic data framework for probe data elements and probe messages, the definition of core data elements, the definition of an initial set of additional probe data elements, and the definition of example probe messages.

This International Standard facilitates the work of system developers and operators who need to specify probe data elements and probe messages:

There are many ways that probe data elements and probe messages could be defined. This International Standard provides a concrete and common way to define probe data elements and probe messages. The standard also facilitates communication and mutual understanding among the developers and the operators of probe vehicle systems.

The ability to develop probe vehicle systems in a consistent and uniform manner reduces development time and cost. If a particular probe vehicle system requires additional probe messages that are not yet part of the standard, the existence of a common framework for defining probe data elements/messages helps system developers to develop probe vehicle systems in a uniform way.

Probe data will be collected from many vehicle makes and models from many vehicle manufacturers. This standard provides a basic data framework for handling probe data elements/messages and the concrete definition of major probe data components that help collect and process probe data consistently.

It should be noted that this International Standard does not prescribe a physical communication medium for transmitting probe messages to or from vehicles. This International Standard is intended to be independent of any particular communication medium and to be compatible with any medium that is selected by system developers.

Core data elements and normative probe data elements are covered in Clauses 7 and 8 respectively. Subclause 5.3 and Annex A are of interest to users familiar with information modelling.

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Vehicle probe data for wide area communications

1 Scope

This International Standard specifies the following.

- **Reference architecture for probe vehicle systems and probe data.** This reference architecture provides a general structure for probe vehicle systems within which a wide range of actual probe vehicle systems can be built whose physical characteristics may differ (e.g., in their choice of communications medium). The reference architecture is used to:

  — clarify the major building blocks and logical interconnections of probe vehicle systems for which this standard will be used;

  — categorize probe data in accordance with the information model described below.

- **Basic data framework for probe data elements and probe data.** This framework specifies how to define probe data elements and probe messages. Specifically it provides the following.

  — Rules for mapping information models (as defined in ISO 14817) of probe data to probe data elements/messages. The information models show the logical structure of entities and concepts involved in probe data.

  — Required characteristics of probe data elements and probe data messages.

  — The notation for probe data elements/messages (in XML).

  — Rules for using core data elements and basic data elements (see below), and extensions of data elements in each application domain.

- **Core data element definitions.** Core data elements are basic descriptive elements intended to appear in every probe message. These are the location and the time at which the probe data was sensed.

- **Initial set of probe data elements.** These elements will be commonly used in typical probe data enabled application domains, such as traffic, weather, and safety. Standardizing these probe data elements facilitates the development of probe vehicle systems and the distribution of probe data. This is not intended to be an exhaustive listing of probe data elements.

- **Example probe messages.** These messages define how probe data elements are combined to convey information to probe processing centres. This is not intended to be an exhaustive listing of probe messages.

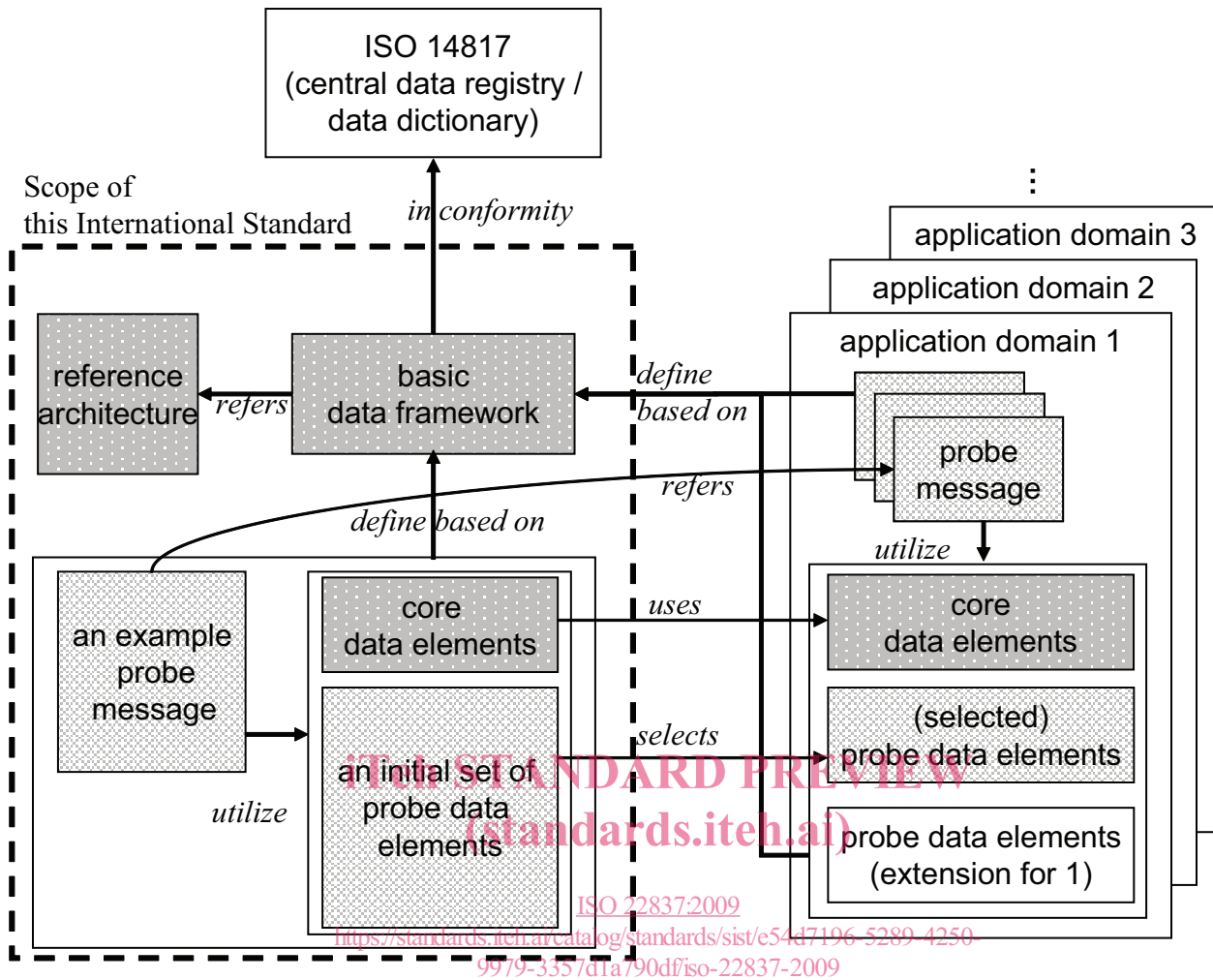Figure 1 depicts the scope described above.

Figure 1 — Scope of this International Standard

To completely define probe processing, the standardization of probe data elements and probe messages is not sufficient. Standards are also required for processed probe data (the output of probe processing) and downlink elements and messages (to convey these results to vehicles and other users). This International Standard prescribes an initial set of probe data elements that are important for transmission from vehicles to land-side processing centres. The standardization of other probe data issues will be addressed in future work.

2 Conformance

Conforming probe data elements shall be defined based on the basic data framework.

Conforming probe messages shall be defined based on the basic data framework, and include core data elements among its members.

Conforming systems do not need to use all probe data elements in this International Standard.

Developers of probe systems may define probe data elements in addition to those listed in the normative portion of this International Standard as extensions. Parties who create extensions to the standard should be cautioned, however, that probe data elements defined outside of this International Standard may not be recognized by all probe data processing centres.

New normative probe data elements may be added to this International Standard through the ISO process.

It is not required to send confidence data in order to conform to this International Standard. If confidence is not known, the field shall be left blank.

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 9000, *SI units and recommendations for the use of their multiples and of certain other units*

ISO/IEC 8824-1:2002, *Information technology — Abstract Syntax Notification One (ASN.1): Specification of basic notation*

ISO 14817, *Transport information and control systems — Requirements for an ITS/TICS central Data Registry and ITS/TICS Data Dictionaries*

4   Terms and definitions

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

4.1
probe vehicle system
system consisting of vehicles which collect and transmit probe data and land-based centres which collate and process data from many vehicles to build an accurate understanding of the overall roadway and driving environment

4.2
vehicle sensor
device within a vehicle that senses conditions inside and/or outside the vehicle or that detects actions that the driver takes

4.3
probe data
vehicle sensor information, formatted as probe data elements and/or probe messages, that is processed, formatted, and transmitted to a land-based centre for processing to create a good understanding of the driving environment

4.4
probe data element
data item included in a probe message

4.5
core data element
probe data element which appears in all probe messages

4.6
probe message
structured collation of data elements suitable to be delivered to the onboard communication device for transmission to a land-based centre

NOTE   It is emphasized that a probe message will not contain any information that identifies the particular vehicle from which it originated or any of the vehicle's occupants, directly or indirectly. In delivering a probe message to be transmitted by the onboard communication device, the onboard data collection system will request that the message be packaged and transmitted without any vehicle or occupant identifying information.

4.7
processed probe data
data from probe data messages which has been collated and analysed in combination with other data

5   Reference architecture

5.1   General

The reference architecture for this International Standard consists of the reference architecture for probe vehicle systems and the reference architecture for probe data.

The reference architecture for probe vehicle systems is designed to present an initial categorization of system components and the relationship among them.

The reference architecture for probe data is designed to present the initial categorization of probe data. The reference architecture for probe data is also referred as the information model for probe data.

5.2   Reference architecture for probe vehicle systems

The reference architecture for probe vehicle systems presents the initial categorization of system components and their relationships from a conceptual point of view. A component is depicted as a UML class and represents an encapsulation of functions and data that is conceptually considered as an individual entity in the probe vehicle system. A relationship is depicted as a UML association and represents potential control and/or data flow among components.

Figure 2 shows the overall structure of the reference architecture for probe vehicle systems.
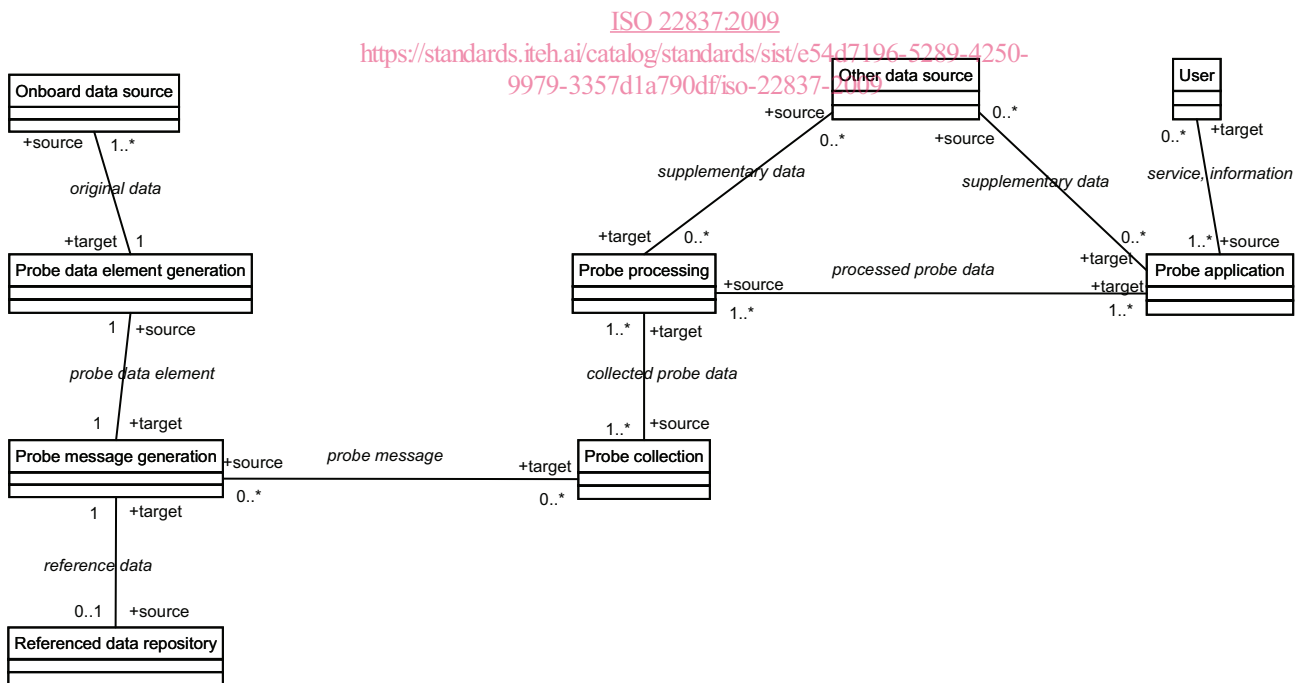

Figure 2 — Reference architecture for probe vehicle systems (overall structure)

The reference architecture comprises the following components.

- **Onboard data source.** The onboard data source provides original data that will become a probe data element. Original data may be raw sensor data or data from other onboard applications. Onboard data sources may be (various types of) sensors, onboard systems, and so on.

- **Probe data element generation.** Probe data element generation creates probe data elements from original data. All of the following cases are included.

  1) No processing (probe data element is identical to original data).

  2) Normalize original data (probe data element is the result of performing a calculation or transformation on original data).

  3) Process original data to generate a new type of data (multiple items of original data are processed, possibly over a time period, to produce the probe data element, e.g. "traffic jam detected").

- **Probe message generation.** Probe message generation creates and formats probe messages from probe data elements and sends them to probe collection. Here, "send" is at the application layer, not the communication layer. Probe message generation manages the timing of sending messages as an application issue. Actual message transmission out the vehicle is left to the communication layer. Probe message generation may refer stored reference data, to assist with data transformation or to help determine whether a probe message should be sent.

- **Referenced data repository.** Referenced data repository holds data for reference by the probe message generator.

- **Probe collection.** Probe collection is a land-side activity that receives probe messages sent by vehicles and extracts probe data from these messages.

- **Probe processing.** Probe processing receives collected probe data from probe collection and processes it (for example, using analysis and fusion). Probe processing does not receive any information from probe collection that identifies the vehicle or driver.

- **Probe application.** Application which uses information produced by probe processing.

- **Other data source.** Other data source provides additional data that is used for probe processing and/or by probe applications. Other data sources may be road authorities, police, weather information providers, and so on.

- **User.** Entity that receives services and/or information produced from probe data. Users may be drivers, road authorities, police, weather services, public agencies, individual users (of cell phones, PDAs), and so on.

Each relationship in this reference architecture is represented as a data and/or control flow, defined as follows:

- **Original data.** Data used for probe data generation. Original data may be raw sensor data or data from other onboard applications.

- **Reference data.** Data stored in a repository and referred to for probe data generation. Reference data may be (among other things) historical data and/or statistical data.

- **Probe data element.** The result of formatting original data into a form suitable to be incorporated as an element of a probe message. (For the general definition of probe data element, see 4.4.)

- **Probe message.** A message in the application layer. A probe message consists of several probe data elements (always including core data elements) that convey meaningful information to centre-side probe collection components. (For the general definition of probe message, see 4.6.)

- **Collected probe data.** Probe data collected by the probe collection component, to be sent to probe processing components.

- **Supplementary data.** Data from other data sources (non-vehicle) that is also used in probe processing and/or by probe applications.

- **Processed probe data.** The result of fusing and analysing probe data in combination with supplementary data; the result of probe processing. (For the general definition of processed probe data, see 4.7.)

- **Service information.** The value-added result of combining processed probe data with supplementary data for delivery to users.

5.3   Reference architecture for probe data (information model)

The reference architecture for probe data represents the initial categorization of probe data from a conceptual point of view.

The reference architecture for probe data consists of multiple packages in UML notation. Each package includes conceptual entities that are identified from a specific point of view. Each conceptual entity is depicted as a UML class.

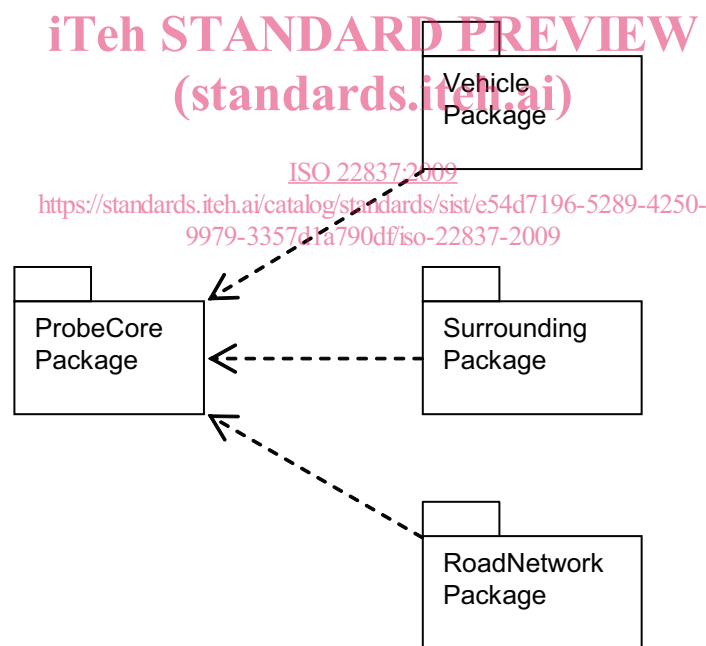Figure 3 is the overall package structure of the reference architecture for probe data.

Figure 3 — Reference architecture for probe vehicle systems (Package structure)

Each package includes the conceptual entities from a different specific viewpoint. Each conceptual entity is an object class. Each class has properties. Figure 4 shows the conceptual entities for the ProbeCorePackage, for example. All of the packages and entities are explained in Annex A.
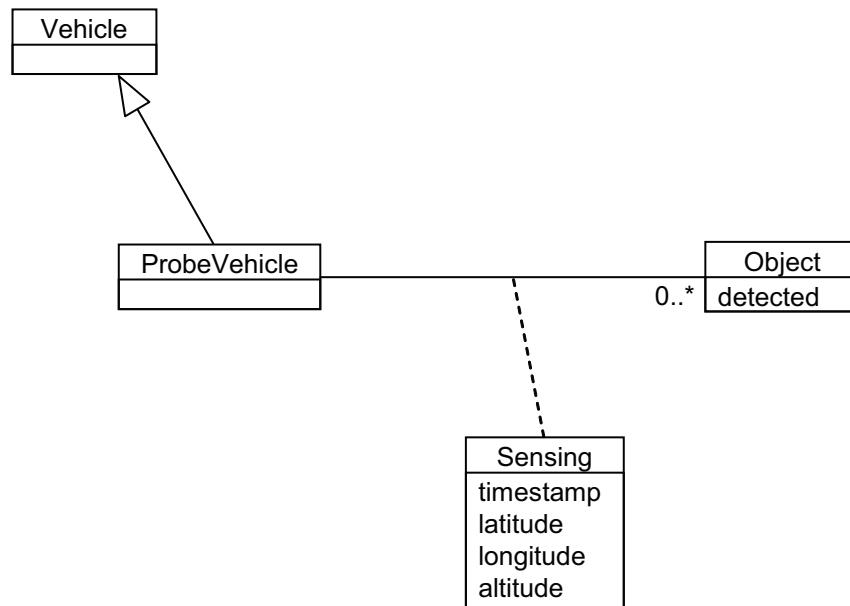
Figure 4 — Entities of ProbeCorePackage

6 Basic data framework

6.1 General

The basic data framework specifies the requirement for defining probe data elements and probe messages.

6.2 Probe data element

The following are the requirements for defining a probe data element.

- A probe data element is shown by a pair consisting of a property of a class and a value domain. That is, it is expressed in the form of ObjectClassTerm.propertyTerm:value-domain-term.

- Each probe data element shall have the following meta-attributes; those basic meta-attributes specified as mandatory in ISO 14817 or defined as optional in ISO 14817 but mandatory for probe data elements.

  — **descriptive name**: A name of the probe data element in the form of "ObjectClassTerm.propertyTerm:value-domain-term". Descriptive name is used for the identification of the probe data element.

  — **ASN.1 name**: The ASN.1 Name shall be the name of a data concept expressed as a valid "typereference" as defined in 11.2 of ISO/IEC 8824-1:2002.

  — **ASN.1 object identifier**: A unique ASN.1 object identifier in accordance with ISO/IEC 8824-1.

  — **definition**: A statement in natural-language text that expresses the essential meaning of the probe data element and assists humans in differentiating the data element from all other data elements.

  — **descriptive name context**: A designation of the ITS/TICS functional area within which the descriptive name is relevant. The descriptive name context for each probe data element is "probe".

— **data concept type**: A categorization of the kind of data concept. The data context type of each probe data element is "data element".

— **standard**: The alphanumeric designation of the standard, or other reference, that defines and describes the probe data element, typically the functional Data Dictionary standard that defines the probe data element.

— **data type**: The logical representation of the probe data element as expressed as a valid data concept instance of an ASN.1 data type.

— **format**: A natural language description of the logical layout of the data concept to facilitate interchange of data.

— **unit of measure**: Units shall be defined in accordance with ISO 1000. For units of enumeration, such as equipment or units of issue, the standard measure shall be defined using this meta-attribute.

— **valid value rule**: A natural language text definition of the rule(s) by which permissible legal instances of a probe data element are identified.

— **data quality**: Specifies the details of data quality for a probe data element. Multiple items may be required to describe data quality, with some items being qualitative and others quantitative.

• When a probe data dictionary is registered to the data registry, it shall comply with ISO 14817; administrative meta-attributes which are mandatory shall be described.

6.3   Probe messages

The following are the requirements for defining a probe message.

• Each probe message consists of a set of probe data elements sent to a centre from the vehicle as a unit.

• Each probe message consists of core data elements and probe data elements.

• Each probe data element included in each probe message satisfies the necessary conditions for probe data elements described above.

• Each probe message shall have the basic meta-attributes defined as mandatory in ISO 14817.

— **descriptive name**: A name of the probe data message in the form of "MessageTerm:message". Descriptive name is used for the identification of a probe message.

— **ASN.1 name**: The ASN.1 name shall be the name of a data concept expressed as a valid "typereference" as defined in 11.2 of ISO/IEC 8824-1:2002.

— **ASN.1 object identifier**: A unique ASN.1 object identifier in accordance with ISO/IEC 8824-1.

— **definition**: A statement in natural-language text that expresses the essential meaning of the probe data message and assists humans in differentiating the message from all other messages.

— **descriptive name context**: A designation of the ITS/TICS functional area within which the descriptive name is relevant. Descriptive name context for each probe data message is "probe".

— **data concept type**: A categorization of the kind of data concept. The data context type of each probe data message is "message".

— **architecture reference**: The name of one or more ITS/TICS Architecture "architecture flow"(s) with corresponding architecture source (subsystem or terminator) and architecture destination (subsystem or terminator) into which this data concept can be meaningfully categorized in whole or in part.

— **architecture name**: The designator (e.g., the title or number) of an ITS/TICS or other architecture that contains the architecture reference(s).

— **architecture version**: The version number of an ITS/TICS or other architecture that contains the architecture reference(s).

— **metadata source**: Indicates whether or not each data element in the message is defined in this dictionary; here "direct", which means all probe data elements in probe data messages are defined in this dictionary.

— **priority**: Indicates whether a message should receive priority treatment. If applicable, the priority scheme and/or the priority of the message may be specified.

— **frequency / message mode**: Indicates the expected timing or rate of occurrence of an instance of this message. Additionally, indicates the message mode for periodic messages.

— **referenced data frames**: A set of data frames which are involved in the message. Multiples allowed.

— **referenced data elements**: A set of data elements which are involved in the message. To identify these referenced data elements, their descriptive names are used.

— **data type**: The logical representation of the message as expressed as a valid message instance of an ASN.1 data type. The text of this meta-attribute shall consist of a complete and syntactically correct ASN.1 module definition.

6.4 Notation

Probe data elements and probe messages defined in this framework are defined in the following XML format.

```
<?xml version="1.0" encoding="UTF-8" ?>

<probe_dictionary>

<probe_data_element descriptive_name="(descriptive name written here)">

    <ASN.1_name> <!-- ASN.1 name--> </ASN.1_name>

    <ASN.1_object_identifier> <!-- ASN.1 object identifier --> </ASN.1_object_identifier>

    <definition> <!-- definition --> </definition>

    <descriptive_name_context>probe</descriptive_name_context>

    <data_concept_type>data element</data_concept_type>

    <standard> <!-- standard, if any --> </standard>

    <data_type> <!-- data type --> </data_type>

    <format> <!-- format --> </format>

    <unit_of_measure> <!-- unit of measure --> </unit_of_measure>

    <valid_value_rule> <!-- valid value rule --> </valid_value_rule>

    <data_quality> <!-- data quality --> </data_quality>

</probe_data_element>
```