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Intelligent transport systems — Probe data reporting management (PDRM)

Systèmes intelligents de transport — Management de rapport de données de sonde (PDRM)

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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.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of document:

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An ISO/PAS or ISO/TS is reviewed after three years in order to decide whether it will be confirmed for a further three years, revised to become an International Standard, or withdrawn. If the ISO/PAS or ISO/TS is confirmed, it is reviewed again after a further three years, at which time it must either be transformed into an International Standard or be withdrawn.

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/TS 25114 was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems*.

Introduction

Probe vehicle systems are being investigated and deployed throughout the world. It is expected that the number of practical systems will grow steadily over the next few years. Since communications airtime will always be a scarce and expensive commodity, efficient probe data reporting systems must rely on techniques to use airtime efficiently and economically. One way to accomplish this is to have the probe processing center guide the economic collection of necessary probe information by sending reporting management instructions to probe vehicles, that is probe data reporting management (PDRM).

As probe vehicle systems have to collect and manage probe data from a variety of vehicles from different vehicle manufacturers, the standardization of these reporting management instructions is essential. To do this, a common framework for PDRM is also required.

This Technical Specification

— helps system developers and operators to specify efficient probe data collection and processing systems; it also promotes communication and mutual understanding among the developers and the operators of probe vehicle systems, and

— helps system developers who are developing probe vehicle systems to define a key tool for communications-efficient probe vehicle systems, i.e. PDRM.

This Technical Specification also provides

a) a reference architecture for PDRM within an architecture which encompasses both this function and PDRM defined in ISO 22837,

b) the basic data framework for defining PDRM instructions, and

c) the concrete definition of these instructions.

PDRM enables a landside probe processing center to issue requests to probe vehicles to optimize probe data reporting. A preliminary set of management instructions for PDRM are defined which support selective probe data reporting and the efficient use of communications airtime.

A reference model is provided which incorporates the reference model of ISO 22837, vehicle probe data for wide area communications, and also encompasses PDRM aspects.

Intelligent transport systems — Probe data reporting management (PDRM)

1 Scope

This Technical Specification provides a common framework for defining probe data reporting management (PDRM) messages to facilitate the specification and design of probe vehicle systems and gives concrete definitions of PDRM messages.

This Technical Specification specifies

a) reference architecture for probe vehicle systems and probe data which incorporates PDRM based on the reference architecture for ISO 22837, and

b) basic data framework for PDRM instructions, which defines specifically

   1) necessary conditions for PDRM instructions, and

   2) notations of these instructions (in XML).

This Technical Specification also provides the rules for using PDRM instructions.

Different types of PDRM messages are also identified and defined, such as

a) PDRM messages consisting of individual instructions which define reporting aspects or requirements for probe vehicle systems,

b) start/stop all probe data reporting,

c) start/stop probe data reporting of specific probe data elements, and

d) generic scheme for conveying criteria for reporting specific probe data elements.

PDRM instructions may be structured in terms of a time period in which they are valid (duration), geographic region, and roadway heading to which the instruction applies.

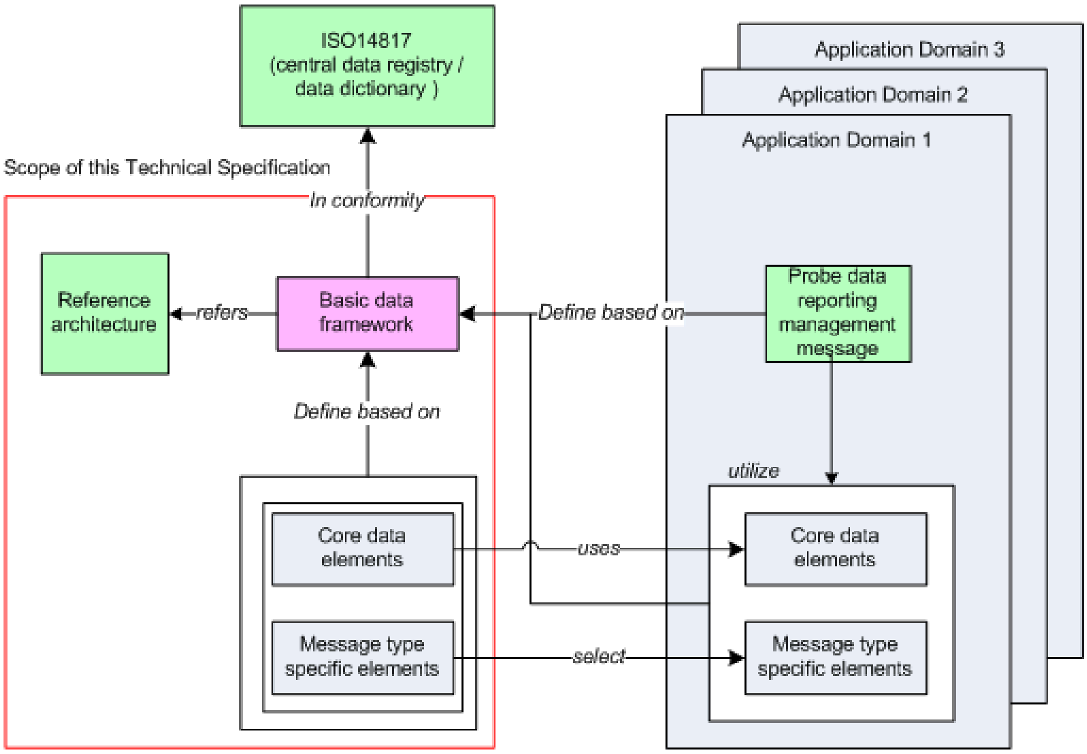

Figure 1 — Scope of this Technical Specification

2 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 14817, *Transport information and control systems — Requirements for an ITS/TICS central Data Registry and ITS/TICS Data Dictionaries*

ISO 22837:2009, *Vehicle probe data for wide area communications*

ISO 1000, *SI units and recommendations for the use of their multiples and of certain other units*

ISO/IEC 8824-1:2008, *Information technology — Abstract Syntax Notation One (ASN. 1):Specification of basic notation*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 22837 and the following apply.

3.1
probe data
vehicle sensor information formatted as probe data elements and/or probe messages that is processed, formatted, and transmitted to a land-based center for processing to create a good understanding of the driving environment

3.2
probe data element
data item included in a probe message

3.3
probe message
structured collation of data elements suitable to be delivered to the onboard communication device for transmission to a land-based center

NOTE It is emphasized that a probe message should 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.

3.4
PDRM commands
commands sent within probe vehicle systems to manage the content and transmission of probe messages

EXAMPLES

— Selectively enable or disable various levels of probe data reporting

— Selectively enable or disable reporting of particular types of probe data

— Adjust the criteria for probe data reporting for specific probe data elements (for example, do not report a smaller than ±3 degree difference in air temperature)

— Adjust the criteria for probe data reporting for specific probe data elements based on the delta value

NOTE These PDRM commands can be structured with time and/or geographic information to define a context in which they are valid.

3.5
PDRM common data element
one of several data elements that are included in all PDRMs

3.6
PDRM instruction type-specific elements
elements particular to the PDRM instruction type

NOTE The instruction types are data capture, threshold and delta.

3.7
PDRM messages
message containing one or more PDRM instructions within a message structure

3.8
probe vehicle system
system consisting of vehicles which collect and transmit probe data and land-based centers which collate and process data from many vehicles to build an accurate understanding of the overall roadway and driving environment

3.9
processed probe data
data from probe data messages which has been collated and analysed in combination with other data

3.10
vehicle sensor
device within a vehicle that senses conditions inside and/or outside the vehicle or that detects actions that the driver takes

4 Reference architecture

4.1 General

Meta-architecture encompassing PDRM messages and also probe data reporting is specified in ISO 22837.

The reference architecture for PDRM 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 PDRM instructions. 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 PDRM instructions.

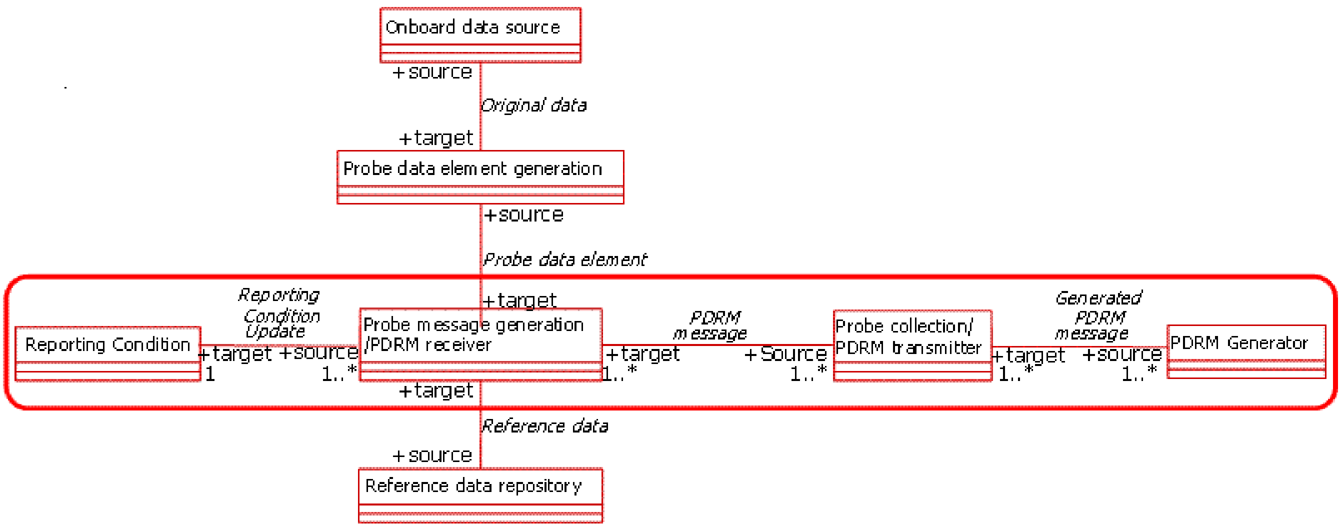

Figure 2 — Reference architecture for PDRM

The components of this reference architecture are specified in 4.2 and 4.3.

4.2 Referenced data repository

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

4.3 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 or onboard systems.

4.4 PDRM generator

Landside provides the mechanism that creates the PDRM message as specified by the probe processing center.

4.5 Probe data element generation

Probe data element generation describes a process for creating probe data elements from original data, including

a) no processing (probe data element is identical to original data),

b) normalizing original data (probe data element is the result of performing a calculation or transformation on original data), and

c) processing original data to generate 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").

4.6 Probe collection

Probe collection describes a process a landside activity undertakes that receives probe messages sent by vehicles and extracts probe data from these messages.

4.7 PDRM transmitter

The PDRM transmitter functionality sends PDRM messages as described by the PDRM generator.

4.8 Reporting condition

The probe data reporting condition of a probe message is determined by a PDRM message. This Technical Specification expects on-board devices utilizing this Technical Specification to possess the ability to process PDRM messages based on the availability of the probe data elements to the on-board device or vehicle.

4.9 PDRM message

A PDRM message is a message in a probe vehicle system that contains commands for controlling probe data collection and transmission. Commands include

a) selectively enabling or disabling various levels of probe data reporting,

b) selectively enabling or disabling reporting of particular types of probe data,

c) adjusting the criteria for probe data reporting for specific probe data elements (for example, do not report a smaller than ± 3 degree difference in air temperature), or

d) adjusting the criteria for probe data reporting for specific data elements based on the delta value. These messages can be structured with time and/or geographic information which define windows/regions within which to apply the instructions.

4.10 Probe message generation

Describes a process by which probe messages are created. This may involve commands in PDRM messages and other criteria not specifically contained in a PDRM message.

4.11 PDRM receiver

Describes the process a probe vehicle system follows to provide a filtering functionality based on received PDRM messages. The PDRM receiver receives PDRM messages and processes for relevance to vehicle location, heading and time.

5 Basic data framework

5.1 General

The basic data framework describes the way to define PDRM instructions. Each message is specified in accordance with ISO 14817. As the PDRM message is based on the probe messages described in ISO 22837, the probe data elements and probe message formats shall conform to the data framework therein.

5.2 PDRM data element

The following are the requirements for specifying a PDRM data element.

a) A PDRM data element shall consist of a (property of a class, value) pair, e.g. ObjectClassTerm.propertyTerm:value-domain-term.

b) Each PDRM data element should have the following meta attributes:

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

   2) **ASN.1 name**: The ASN.1 name shall be the name of a data concept expressed as a valid "typereference" as defined in 12.2 of ISO/IEC 8824-1:2008.

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

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

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

   6) **data concept type**: A categorization of the kind of data concept. The data context type of each PDRM data element is "PDRM data element".

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

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

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

   10) **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.

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

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

NOTE These basic meta attributes are specified either as mandatory or as optional in ISO 14817, but are mandatory for PDRM data elements.

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

5.3 PDRM messages

The following are the requirements for defining a PDRM message.

a) Each PDRM message consists of an instruction set of PDRM data elements sent to a vehicle from a probe processing center as a unit.

b) Each probe message consists of PDRM common data elements and PDRM instruction type-specific elements.

c) Each PDRM data element included in each PDRM message satisfies the necessary conditions for PDRM data elements described above.

d) Each PDRM message should have the following basic meta attributes, as defined in ISO 14817:

   1) **descriptive name**: A name of the PDRM message in the form of "MessageTerm:message". Descriptive name is used for the identification of a PDRM message.

   2) **ASN.1 name**: The ASN.1 name shall be the name of a data concept expressed as a valid "typereference" as defined in 12.2 of ISO/IEC 8824-1:2008.

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

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

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

   6) **data concept type**: A categorization of the kind of data concept. The data context type of each PDRM message is "message".

   7) **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.

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

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

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

   11) **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 PDRM common data elements

6.1 General

Conforming PDRM messages and the instructions contained therein are defined based on the basic data framework. Each PDRM instruction shall contain the basic PDRM common data elements. These PDRM common data elements include the number of PDRM instructions, PDRM instruction type, vehicle type code, geo-specific address type, geo-specific address data, vehicle heading, roadway heading, reporting frequency, and the probe data element to which the command applies.

The concept of PDRM common data elements identifies the PDRM common data element set between the different message types. This concept does not intend to reflect a generic message framework and should not be treated as such. Each PDRM instruction defines a different parameter set and is applicable to different probe message generation use cases.

6.2 DataElement

The DataElement field identifies the probe data element the PDRM applies to. This field references and is applied in accordance with ISO 22837.

6.3 PDRStopTime

The PDRStopTime element field indicates the time the vehicle should stop probe data reporting in accordance with the condition identified in the PDRM instruction. This field references and is applied in accordance with ISO 22837.

6.4 PDRStartTime

The PDRStartTime element field indicates the start time at which the vehicle should begin probe data reporting. This field references and is applied in accordance with ISO 22837.

6.5 Heading

The heading value indicates the heading to which the PDRM message pertains. The field is a variable size dependent on the heading type utilized.

6.6 NumInstructions

The PDRM message framework supports the transmission of multiple instructions in a message set. The NumInstructions element, represented as a byte, indicates the number of instructions included in the PDRM message.

6.7 NumRegions

The message framework supports the use of multiple region objects. The NumRegions element, represented as a byte, indicates the number of region objects included in the instruction.

6.8 PDRM instruction type

The instruction type code indicates the PDRM instruction type represented as a byte. The PDRM instruction type codes are defined in Table 3.

6.9 Region

The region object represents the region PDRM message reporting region. The region object consists of a RegionType object and RegionData object.

6.10 RegionType

The geo-specific address type, represented as a byte, indicates the PDRM geographic reporting region.

6.11 RegionData

The geo-specific address data defines the geographical region as a REAL data type. The field is a variable size dependent on the geo-specific address type code.

6.12 Reporting frequency

The reporting frequency value, listed in Table 3, sets the frequency to seconds for a probe message sent to the probe processing center. The value is represented as an integer with a possible range of values of 0 to 9999. A value of 0 instructs the vehicle to stop reporting the associated data element.

6.13 RoadwayHeading

The RoadwayHeading indicates the general roadway designator heading to which the PDRM instruction pertains. The value is an enumeration of an eight-point compass. Any combination of settings may be used to identify a heading region. The valid listed settings are defined in Table 1.

Table 1 — Roadway heading sector mapping

Roadway heading
North
NorthEast
East
SouthEast
South
SouthWest
West
NorthWest

6.14 Vehicle heading

The vehicle heading indicates the general GPS heading for which the PDRM command is valid. The value is an enumeration of 16 sectors of 22,5 degrees each. Any combination of settings may be used to identify a heading region. The valid settings are listed in Table 2.

Table 2 — Vehicle heading sector mapping

Heading sector
0 - 22,5
22,5 - 45
45 - 67,5
67,5 - 90
90 - 112,5
112,5 - 135
135 - 157,5
157,5 - 180
180 - 202,5
202,5 - 225
225 - 247,5
247,5 - 270
270 - 292,5
292,5 - 315
315 - 337,5
337,5 - 360

6.15 VehicleType

The address to type of vehicle code, represented as a byte, identifies the target vehicle type for the PDRM message. Vehicle type codes are specified in ISO 22837. The PDRM data element can select a specific vehicle type or "all" for all vehicle types.

Table 3 — Common data elements

Name	Description	Data Source	Data Type	Format	Unit of Measure	Valid Value Rule	Data Quality
NumInstructions	Defines the number of instruction sets included in this PDRM message	Probe processing center	Byte	0 - 255	Byte	byte{0..255}	n/a
InstructionType	Defines the type of probe data reporting instruction	Probe processing center	Byte	0 = Data capture 1 = threshold 2 = Delta	Code	byte{0..2}	n/a
VehicleType	Pointer to type of vehicle (code as per ISO 22837:2009)	Probe processing center	Integer	Pointer to type of vehicle (code as per ISO 22837:2009)	Code	integer {0…255}	n/a
NumRegions	Defines the number of region objects included in this instruction set	Probe processing center	Byte	0 – 255	Byte	byte{0..255}	n/a
Region	Geo-specific region	Probe processing center	Region::=SEQUENCE { regionType RegionType, regionData RegionData}			SEQUENCE{1..n}	n/a
RegionType	Geo-specific region address type	Probe processing center	Byte	1 = all 2 = functional road class 3 = rectangular boundary 4 = circularBoundary	Code	byte {1..3}	n/a

Table 3 (*continued*)

Name	Description	Data Source	Data Type	Format	Unit of Measure	Valid Value Rule	Data Quality
RegionData.functional RoadClass	Functional road class as per WG3 location reference standards	Probe processing center	Functional road class as per WG3 location reference standards	Functional road class as per WG3 location reference standards	Code	Functional road class as per WG3 location reference standards	n/a
RegionData.rectangular Boundary	Geographical zone identified by four GPS points	Probe processing center	LocationDegree::= SEQUENCE { degree REAL (Latitude), degree REAL (Longitude)}	latitude[-90…90] / longitude [-180…180]	Degree	SEQUENCE{1..4}	n/a
RegionData.circular Boundary	Geographical zone identified by a GPS point and radius of the circular region	Probe processing center	SEQUENCE { center LocationDegree, radius INTEGER}	latitude[-90…90] / longitude [-180…180], integer [0…65535].	Degree, integer	SEQUENCE{ LocationDegree, integer[0…65535]}	n/a
HeadingType	Heading data type	Probe processing center	Byte	1 = vehicle heading 2 = roadway heading	Code	byte {1..2}	n/a

Table 3 (*continued*)

Name	Description	Data Source	Data Type	Format	Unit of Measure	Valid Value Rule	Data Quality
Heading.VehicleHeading	Heading segmented into 16 sectors Each segment equals 22.5 degrees	Probe processing center	Heading.Vehicleheading::= SEQUENCE{ vHeading BIT STRING SIZE (16)}	0 - 22.5 22.5 - 45 45 - 67.5 67.5 - 90 90 - 112.5 112.5 - 135 135 - 157.5 157.5 - 180 180 - 202.5 202.5 - 225 225 - 247.5 247.5 - 270 270 - 292.5 292.5 - 315 315 - 337.5 337.5 - 360	Code	SEQUENCE{0…65535}	n/a
Heading.RoadwayHeading	Based on designated roadway direction	Probe processing center	Heading.RoadwayHeading::= SEQUENCE{ rHeading BIT STRING SIZE (8) reserved SIZE(8)}	North NorthEast East SouthEast South SouthWest West NorthWest	Code	SEQUENCE{ byte{0..255} byte{0..255}}	n/a

Table 3 (*continued*)

Name	Description	Data Source	Data Type	Format	Unit of Measure	Valid Value Rule	Data Quality
DataElement	Normative Probe Data Element name (ISO 22837:2009)	Probe processing center	Normative probe data element name (ISO 22837:2009) or "all"	ISO 22837:2009	ISO 22837:2009	ISO 22837:2009	n/a
ReportingFrequency	Reporting frequency of probe data	Probe processing center	Integer	0 - 9999 0 = stop	Seconds	0 - 9999	n/a
PDRStartTime	Start timestamp for probe data reporting Based on January 1, 1970 (same as "UNIX epoch time")	Probe processing center	REAL	Second	Second	Integer	n/a
PDREndTime	Stop timestamp for probe data reporting Based on January 1, 1970 (same as "UNIX epoch time")	Probe processing center	REAL	Second	Second	Integer	n/a

7 PDRM instruction definitions

7.1 General

Three distinct PDRM instructions allow the probe data processing center to tailor probe data reporting. The instruction types are defined in 7.2 to 7.4.

Developers of probe vehicle systems may define PDRM instructions in addition to those defined in 7.2 to 7.4 as extensions. Parties who create extensions to this Technical Specification should be cautioned, however, that PDRM instructions defined outside of this Technical Specification may not be recognized by all probe vehicle systems.

7.2 Data capture instruction

The data capture instruction, depicted in Table C.1, allows a probe processing center to selectively enable or disable various levels of probe data reporting and selectively enable or disable reporting of particular types of probe data. The instruction type-specific elements for this message are described in Table 4.

7.3 Threshold instruction

The threshold reporting instruction, depicted in Table C.2, allows the probe processing center to adjust the criteria for probe data reporting for specific data elements (for example, do not report a smaller than ±3 degree difference in air temperature). The instruction type-specific elements for this message are described in Table 4.

7.3.1 Threshold

The threshold value, defined in Table 4, establishes the breakpoint at which a vehicle should initiate a probe message. The value is expressed in units defined in ISO 22837.

7.3.2 ThresholdDirection

The ThresholdDirection, defined in Table 4, defines whether the threshold is positive, negative or both of the data element values.

7.4 Delta instruction

The delta instruction, depicted in Table C.3, allows the probe processing center to adjust the criteria for probe data reporting for specific data elements based on the delta value. A delta instruction provides the means of receiving probe messages generated from exception type events.

7.4.1 DeltaValue

The DeltaValue depicted in Table 4, defines the breakpoint value at which a vehicle should initiate a probe message. The value is expressed in units defined in ISO 22837.

7.4.2 DeltaDirection

The DeltaDirection, defined in Table 4, defines whether the threshold is positive, negative or both of the data element values.

7.4.3 TimeDiff

The TimeDiff element, defined in Table 4, defines the timeframe in seconds in which the delta quotient is calculated. This is represented as an integer value with a range from 0 – 9999.

Table 4 — Instruction specific elements

Name	Description	Data Source	Data Type	Format	Unit of Measure	Valid Value Rule	Data Quality
Threshold	Normative probe data units (ISO 22837:2009)	Probe processing center	Normative probe data units (ISO 22837:2009)				
ThresholdDirection	Direction of interest of threshold value	Probe processing center	Byte	0 = greater than 1 = less than 2 = both	Code	{0 - 2}	
DeltaValue	Normative probe data units (ISO 22837:2009)	Probe processing center	Normative probe data units (ISO 22837:2009)				
DeltaDirection	Direction of interest of delta value	Probe processing center	Byte	0 = greater than 1 = less than 2 = both	Code	{0 - 2}	
TimeDiff	The time differential used for calculating the delta value	Probe processing center	Integer	0 - 9999	Seconds	0 - 9999	

Annex A
(informative)

PDRM operational concept

A.1 General

The purpose of this annex is to provide a general background and operational concept of the PDRM message set. While probe processing centers and probe generation is in its infancy stages, this Technical Specification provides a foundation for modification of the probe generation process. Essentially, a PDRM implementation is intended to reduce wireless link traffic and the processing load on backhaul data processing and aggregation centers.

The PDRM message set provides a mechanism to modify the frequency, type, and dataset provided by probe messages sent from probe vehicles and their devices. This mechanism enhances traffic management and traveller information systems by allowing the probe processing centers to tailor the message set received. Thus, resources may be directed more efficiently during the probe processing process. The aggregation of data is a major portion of the probe processing center functionality. Managing the probe generation process will ensure efficient aggregation.

Depending on the implementation of probe data generation, issues may occur related to bandwidth usage. Probe data is generally considered an important part of the mobile communications model, yet is deemed the least critical. When unmanaged, and probe data is generated simply according to default configuration, a network may be flooded with probe data and limit the effectiveness of other message sets that are more critical to safety and mobility. Appropriate measures require a mechanism to ensure manageable data generation for efficient throughput within the communications infrastructure.

A.1.1 PDRM message set purpose

The PDRM message set is intended to allow processing centers the ability to tailor the generation of probe data. Current probe processing implementations only provide a mechanism to receive all probe data generated from probe devices. This will allow processing centers to efficiently process data sets applicable for the respective implementation. The message set allows for three different message types or instructions: data capture, threshold, and delta.

A.1.2 Data capture enable/disable

The data capture instruction allows a probe processing center to enable or disable various levels of probe data reporting and selectively enable or disable reporting of particular types of probe data. Data elements are selected and expressed in units as defined in ISO 22837. This instruction is the basic or default instruction set from the probe processing center.

A.1.3 Threshold event

The threshold value establishes the breakpoint at which a vehicle should initiate a probe message. A processing center may be interested in probe data elements that reach or drop to certain levels or operating parameters. Examples of this may be traffic management centers interested in dropping speeds in certain areas below a set limit; research entities concerned only with temperature values above normal operating range; or roadway maintenance organizations concerned only with extreme wheel vertical G-force which may identify defective road surfaces.

A.1.4 Delta event

The delta reporting instruction allows the probe processing center to adjust the criteria for probe data reporting for specific data elements based on the delta value. Delta values provide a mechanism to calculate a value differential from a specific data element over a given amount of time. Similar to the threshold event type trigger, should the value exceed the given reference value positively or negatively, a message will be generated. Examples of delta instruction use may be traffic management or public safety agencies monitoring speed acceleration and de-acceleration in an area over a given time, automotive organizations interested in operational parameter characteristics and trouble shooting, or research agencies interested in traffic trending and characteristics.

A.1.5 Message framework

The message framework consists of common and message-specific elements. This model allows for the different instructions to follow a common template while providing extensibility for new instruction types in the future. In addition, the data element definition has been abstracted from this Technical Specification. Data elements are defined and attributes described in ISO 22837. This Technical Specification is modular in that new data elements may be added as new technology is made available and lessons are learned in the probe generation process.

Annex B
(informative)

PDRM elements

This annex provides the XML representation of the data elements contained within the PDRM message set.


```
<?xml version="1.0" encoding="UTF-8"?>
<xs:element name="pdrmMessage">
    <xs:annotation>
        <xs:documentation>The PDRM message wrapper for the message data elements</xs:documentation>
    </xs:annotation>
   <ASN.1_name> pdrmMessage</ASN.1_name>
    <ASN.1_object_identifier>1 0 25114 000 017</ASN.1_object_identifier>
<definition></definition>
    <descriptive_name_context> pdrmMessage </descriptive_name_context>
    <data_concept_type>data element</data_concept_type>
    <standard>n.a. </standard>
    <data_type>complex </data_type>
    <format>complex data type</format>
    <unit_of_measure>n.a.</unit_of_measure>
    <valid_value_rule> n.a.</valid_value_rule>
    <data_quality>n.a.</data_quality>
</xs:element>

<?xml version="1.0" encoding="UTF-8"?>
<xs:element name="numInstructions">
    <xs:annotation>
        <xs:documentation>0…255</xs:documentation>
    </xs:annotation>
   <ASN.1_name> numInstructions</ASN.1_name>
    <ASN.1_object_identifier>1 0 25114 000 000</ASN.1_object_identifier>
<definition></definition>
    <descriptive_name_context> numInstructions</descriptive_name_context>
    <data_concept_type>data element</data_concept_type>
    <standard>n.a. </standard>
    <data_type>byte</data_type>
    <format>{0…255}</format>
    <unit_of_measure>byte</unit_of_measure>
```

```
    <valid_value_rule> byte [0...255]</valid_value_rule>
    <data_quality>n.a.</data_quality>
</xs:element>


<xs:element name="instructionType">
    <xs:annotation>
        <xs:documentation>0 = Data Capture; 1 = Threshold; 2 = Delta</xs:documentation>
    </xs:annotation>
   <ASN.1_name>instructionType</ASN.1_name>
    <ASN.1_object_identifier>1 0 25114 000 001</ASN.1_object_identifier>
   <definition></definition>
    <descriptive_name_context> instructionType </descriptive_name_context>
    <data_concept_type>data element</data_concept_type>
    <standard>n.a. </standard>
    <data_type>byte</data_type>
    <format>{0,1,2}</format>
    <unit_of_measure>code</unit_of_measure>
    <valid_value_rule> byte [0...2]</valid_value_rule>
    <data_quality>n.a.</data_quality>
</xs:element>

<xs:element name="vehicleType">
    <xs:annotation>
        <xs:documentation>enum... 0 - 255</xs:documentation>
    </xs:annotation>
   <ASN.1_name>vehicleType</ASN.1_name>
    <ASN.1_object_identifier>1 0 25114 000 002</ASN.1_object_identifier>
   <definition></definition>
    <descriptive_name_context> vehicleType </descriptive_name_context>
    <data_concept_type>data element</data_concept_type>
    <standard>n.a. </standard>
    <data_type>integer</data_type>
    <format> Address to type of vehicle (code from ISO 22837:2009) </format>
    <unit_of_measure>code</unit_of_measure>
    <valid_value_rule> byte [0...255]</valid_value_rule>
    <data_quality>n.a.</data_quality>
</xs:element>
```

```
<xs:element name="regionType">
        <xs:annotation>
            <xs:documentation>1,2,3, or 4</xs:documentation>
        </xs:annotation>
    <ASN.1_name>regionType</ASN.1_name>
        <ASN.1_object_identifier>1 0 25114 000 003</ASN.1_object_identifier>
   <definition> Geo-specific region Address Type</definition>
        <descriptive_name_context> RegionType </descriptive_name_context>
        <data_concept_type>data element</data_concept_type>
        <standard>n.a. </standard>
        <data_type>byte</data_type>
        <format> 1 = all, 2 = functional road class, 3 = rectangular boundary 4=circularBoundary </format>
        <unit_of_measure>code</unit_of_measure>
        <valid_value_rule> byte [1...4]</valid_value_rule>
        <data_quality>n.a.</data_quality>
    </xs:element>


    <xs:element name="data" type="regionData">
    <ASN.1_name>regionData</ASN.1_name>
        <ASN.1_object_identifier>1 0 25114 000 004</ASN.1_object_identifier>
   <definition></definition>
        <descriptive_name_context> RegionData </descriptive_name_context>
        <data_concept_type>data element</data_concept_type>
        <standard>Empty</standard>
        <data_type> RegionData </data_type>
        <format> n.a. </format>
        <unit_of_measure>n.a.</unit_of_measure>
        <valid_value_rule>n.a.</valid_value_rule>
        <data_quality>n.a.</data_quality>
    </xs:element>


<xs:element name="functionalRoadClass"/>
   <xs:annotation>
        <xs:documentation>regionType = 2</xs:documentation>
    </xs:annotation>
   <ASN.1_name> RegionData.functionalRoadClass </ASN.1_name>
    <ASN.1_object_identifier>1 0 25114 000 005</ASN.1_object_identifier>
<definition> Functional Road Class per WG3 location reference standards </definition>
    <descriptive_name_context>RegionData.functionalRoadClass  </descriptive_name_context>
```

```
    <data_concept_type>data element</data_concept_type>
    <standard>Empty</standard>
    <data_type> RegionData.functionalRoadClass </data_type>
    <format> n.a. </format>
    <unit_of_measure>n.a.</unit_of_measure>
    <valid_value_rule>n.a.</valid_value_rule>
    <data_quality>n.a.</data_quality>
</xs:element>


<xs:element name="boundary">
   <xs:annotation>
        <xs:documentation>regionType = 3</xs:documentation>
    </xs:annotation>
   <xs:annotation>
        <xs:documentation>The boundary of the rectangle</xs:documentation>
    </xs:annotation>
    <xs:complexType>
        <xs:sequence>
            <xs:element name="point" minOccurs="4" maxOccurs="4">
                <xs:annotation>
              <xs:documentation>A point, defining a corner of the rectangle</xs:documentation>
                </xs:annotation>
                <ASN.1_name> RegionData.RectangularBoundaryRegion </ASN.1_name>
                    <ASN.1_object_identifier>1 0 25114 000 005</ASN.1_object_identifier>
              <definition> Geographical zone identified by 4 GPS points.</definition>
                    <descriptive_name_context> RegionData.RectangularBoundaryRegion
                    </descriptive_name_context>
              <data_concept_type> LocationDegree::= SEQUENCE{degree REAL (Latitude), degree REAL
              (Longitude)}</data_concept_type>
                    <standard>Empty</standard>
                    <data_type> RegionData.rectangularBoundary</data_type>
                    <format> latitude[-90…90] / longitude [-180…180]</format>
                    <unit_of_measure>degree.</unit_of_measure>
                    <valid_value_rule> SEQUENCE{1..4}.</valid_value_rule>
                    <data_quality>n.a.</data_quality>
                <xs:complexType>
                    <xs:sequence>
                        <xs:element name="lat">
                            <xs:annotation>
                                <xs:documentation>Int ISO microdegrees</xs:documentation>
```

```xml
                    </xs:annotation>
                </xs:element>
                <xs:element name="lon">
                    <xs:annotation>
                        <xs:documentation>Int ISO microdegrees</xs:documentation>
                    </xs:annotation>
                </xs:element>
            </xs:sequence>
        </xs:complexType>
    </xs:element>
    </xs:sequence>
  </xs:complexType>
</xs:element>


<xs:element name="circularBoundary">
<xs:annotation>
        <xs:documentation>regionType = 4</xs:documentation>
    </xs:annotation>
<xs:annotation>
        <xs:documentation>The circular boundary of the rectangle</xs:documentation>
    </xs:annotation>
    <xs:complexType>
        <xs:sequence>
            <xs:element name="center" minOccurs="1" maxOccurs="1">
                <xs:annotation>
<xs:documentation>A point, defining the center point of the circle region.</xs:documentation>
                </xs:annotation>
                <ASN.1_name> RegionData.circularBoundaryRegion </ASN.1_name>
                    <ASN.1_object_identifier>1 0 25114 000 006</ASN.1_object_identifier>
<definition> Geographical zone identified by a GPS center point of a circular region and the radius of that circular region.</definition>
                    <descriptive_name_context> RegionData.circularBoundaryRegion
                </descriptive_name_context>
<data_concept_type> SEQUENCE{center LocationDegree, radius INTEGER}</data_concept_type>
                    <standard>Empty</standard>
                    <data_type> RegionData.circularBoundary </data_type>
                    <format> LocationDegree, integer</format>
                    <unit_of_measure>degree, integer.</unit_of_measure>
<valid_value_rule> SEQUENCE{LocationDegree,integer[0…65535]} </valid_value_rule>
                        <data_quality>n.a.</data_quality>
```



```
                <xs:complexType>
                    <xs:sequence>
                        <xs:element name="lat">
                            <xs:annotation>
                                <xs:documentation>Int ISO microdegrees</xs:documentation>
                            </xs:annotation>
                        </xs:element>
                        <xs:element name="lon">
                            <xs:annotation>
                                <xs:documentation>Int ISO microdegrees</xs:documentation>
                            </xs:annotation>
                        </xs:element>
                 <xs:element name="radius">
                            <xs:annotation>
                                <xs:documentation>Int radius</xs:documentation>
                            </xs:annotation>
                        </xs:element>
                    </xs:sequence>
                </xs:complexType>
            </xs:element>
        </xs:sequence>
    </xs:complexType>
</xs:element>


<xs:complexType name="heading" abstract="true">
    <xs:annotation>
        <xs:documentation>0 or 1</xs:documentation>
    </xs:annotation>
    <xs:sequence>
        <xs:element name="headingType"/>
        <xs:element name="data" type="headingData"/>
    </xs:sequence>
</xs:complexType>

<xs:element name="vehicleHeading" type="xs:string">
    <xs:annotation>
        <xs:documentation>2 BYTE SEQUENCE</xs:documentation>
    </xs:annotation>
```

```
    <xs:annotation>
          <xs:documentation>headingType = 0</xs:documentation>
     </xs:annotation>
    <ASN.1_name> vehicleHeading </ASN.1_name>
     <ASN.1_object_identifier>1 0 25114 000 007</ASN.1_object_identifier>
    <definition> Heading segmented into 16 sectors. Each segment equals 22.5 degrees.</definition>
    <descriptive_name_context>vehicleHeading
    </descriptive_name_context>
     <data_concept_type>data element</data_concept_type>
     <standard>Empty</standard>
     <data_type> vehicleHeading </data_type>
     <format> 0…65535 </format>
     <unit_of_measure>code</unit_of_measure>
     <valid_value_rule>0…65535</valid_value_rule>
     <data_quality>n.a.</data_quality>
</xs:element>

<xs:element name="roadwayHeading" type="xs:string">
     <xs:annotation>
          <xs:documentation>2 BYTE SEQUENCE</xs:documentation>
     </xs:annotation>
    <xs:annotation>
          <xs:documentation>headingType = 2</xs:documentation>
     </xs:annotation>
    <ASN.1_name> roadwayHeading </ASN.1_name>
     <ASN.1_object_identifier>1 0 25114 000 008</ASN.1_object_identifier>
    <definition> Based on designated roadway direction</definition>
    <descriptive_name_context>RoadwayHeading</descriptive_name_context>
     <data_concept_type>data element</data_concept_type>
     <standard>Empty</standard>
    <data_type> BYTE STRING </data_type>
     <format>0...65535</format>
     <unit_of_measure>code</unit_of_measure>
     <valid_value_rule>0…65535 </valid_value_rule>
</xs:element>

<xs:element name="dataElement">
     <xs:annotation>
        <xs:documentation>Data element to apply this msg to</xs:documentation>
```

```
    </xs:annotation>
    <ASN.1_name>dataElement </ASN.1_name>
        <ASN.1_object_identifier>1 0 25114 000 008</ASN.1_object_identifier>
      <definition>Normative Probe Data Element name (Table 3, ISO 22837:2009)</definition>
      <descriptive_name_context>VehicleHeading</descriptive_name_context>
        <data_concept_type>data element</data_concept_type>
        <standard>Empty</standard>
      <data_type> Normative Probe Data Element name (Table 3, ISO 22837:2009)</data_type>
        <format> </format>
        <unit_of_measure>.</unit_of_measure>
        <valid_value_rule></valid_value_rule>
</xs:element>


<xs:element name="durationStart"/>
   <ASN.1_name> durationStart </ASN.1_name>
    <ASN.1_object_identifier>1 0 25114 000 009</ASN.1_object_identifier>
   <definition> Start timestamp for probe data reporting. Based on January 1, 1970 (same as "UNIX epoch
   time").</definition>
   <descriptive_name_context>DurationStart </descriptive_name_context>
    <data_concept_type>data element</data_concept_type>
    <standard>Empty</standard>
   <data_type>REAL</data_type>
    <format>second</format>
    <unit_of_measure>second</unit_of_measure>
    <valid_value_rule>integer</valid_value_rule>
</xs:element>


<xs:element name="durationEnd"/>
   <ASN.1_name> durationEnd </ASN.1_name>
    <ASN.1_object_identifier>1 0 25114 000 010</ASN.1_object_identifier>
   <definition> End timestamp for probe data reporting. Based on January 1, 1970 (same as "UNIX epoch
   time").</definition>
   <descriptive_name_context> DurationEnd </descriptive_name_context>
    <data_concept_type>data element</data_concept_type>
    <standard>Empty</standard>
   <data_type>REAL</data_type>
    <format>second</format>
    <unit_of_measure>second</unit_of_measure>
    <valid_value_rule>integer</valid_value_rule>
</xs:element>
```

```
<xs:element name="reportingFrequency">
    <ASN.1_name> reportingFrequency </ASN.1_name>
      <ASN.1_object_identifier>1 0 25114 000 011</ASN.1_object_identifier>
    <definition> Reporting frequency of probe data.</definition>
    <descriptive_name_context> ReportingFrequency </descriptive_name_context>
      <data_concept_type>data element</data_concept_type>
      <standard>Empty</standard>
    <data_type>integer</data_type>
      <format>0 – 9999, 0 = stop </format>
      <unit_of_measure>second</unit_of_measure>
      <valid_value_rule>0 – 9999</valid_value_rule>
</xs:element>

<xs:element name="threshold">
    <ASN.1_name> threshold </ASN.1_name>
      <ASN.1_object_identifier>1 0 25114 000 012</ASN.1_object_identifier>
    <definition> Normative Probe Data units (Table 3, ISO 22837:2009)</definition>
    <descriptive_name_context> Threshold </descriptive_name_context>
      <data_concept_type>data element</data_concept_type>
      <standard>Empty</standard>
    <data_type> Normative Probe Data units (Table 3, ISO 22837:2009)</data_type>
      <format> </format>
      <unit_of_measure> </unit_of_measure>
      <valid_value_rule></valid_value_rule>
</xs:element>

<xs:element name="thresholdDirection">
    <ASN.1_name> thresholdDirection</ASN.1_name>
      <ASN.1_object_identifier>1 0 25114 000 013</ASN.1_object_identifier>
    <definition> Direction of interest of threshold value.</definition>
    <descriptive_name_context> ThresholdDirection </descriptive_name_context>
      <data_concept_type>data element</data_concept_type>
      <standard>Empty</standard>
    <data_type>byte</data_type>
      <format>0 = greater than, 1 = less than, 2 = both</format>
      <unit_of_measure>code</unit_of_measure>
      <valid_value_rule>{0 - 2}</valid_value_rule>
</xs:element>
```

```
<xs:element name="deltaValue"/>
   <ASN.1_name> deltaValue </ASN.1_name>
    <ASN.1_object_identifier>1 0 25114 000 014</ASN.1_object_identifier>
   <definition> Normative Probe Data units (Table 3, ISO 22837:2009).</definition>
   <descriptive_name_context> DeltaValue </descriptive_name_context>
    <data_concept_type>data element</data_concept_type>
    <standard>Empty</standard>
   <data_type> Normative Probe Data units (Table 3, ISO 22837:2009)</data_type>
    <format> </format>
    <unit_of_measure> </unit_of_measure>
    <valid_value_rule></valid_value_rule>
</xs:element>

<xs:element name="deltaDirection"/>
   <ASN.1_name> deltaDirection</ASN.1_name>
    <ASN.1_object_identifier>1 0 25114 000 015</ASN.1_object_identifier>
   <definition> Direction of interest of delta value.</definition>
   <descriptive_name_context> DeltaDirection </descriptive_name_context>
    <data_concept_type>data element</data_concept_type>
    <standard>Empty</standard>
   <data_type>byte</data_type>
    <format>0 = greater than, 1 = less than, 2 = both</format>
    <unit_of_measure>code</unit_of_measure>
    <valid_value_rule>{0 - 2}</valid_value_rule>
</xs:element>

<xs:element name="timeDiff"/>
   <ASN.1_name> timeDiff </ASN.1_name>
    <ASN.1_object_identifier>1 0 25114 000 016</ASN.1_object_identifier>
   <definition> The time differential used for calculation the delta value.</definition>
   <descriptive_name_context> TimeDiff </descriptive_name_context>
    <data_concept_type>data element</data_concept_type>
    <standard>Empty</standard>
   <data_type>integer</data_type>
    <format>0 - 9999</format>
    <unit_of_measure>seconds</unit_of_measure>
    <valid_value_rule>0 - 9999</valid_value_rule>
</xs:element>
```

Annex C
(normative)

Probe data reporting message structure

This annex offers a field-based representation of the message structure. Examples are presented by each instruction type. The data capture instruction possesses only the common data elements depicted in Table C.1. The data capture instruction does not possess any unique elements.

Table C.1 — Probe data management common data elements

Field 1	Field 2	Field 3	Field 4	Field 5	Field 6	Field 7	Field 8	Field 9	Field 10	Field 11
NumInstructions	Instruction Type	Address to type of vehicle (code from ISO 22837:2009)	Geo-specific address type	Geo-specific address data	Heading type	Heading value	Apply to data element	Reporting frequency value	Duration start	Duration end
byte	Integer	Integer	Integer	REAL				Integer		
	0 = Data Capture		1 = all	Address type data	0 = Vehicle heading		"all"			
			2 = functional road class	0 = N/A	1 = Roadway heading		or	Unit: seconds		
The number of instructions included in this message.			3 = defined rectangular boundary	Variable field size. Dependent on Field 3 setting.		Variable field defined by Field 5 setting.	Normative probe data element name (Table 3, ISO 22837:2009)	Valid value rule = 0 – 9999 0 = stop reporting	Core probe data units (Table 1, ISO 22837:2009)	Core probe data units (Table 1, ISO 22837:2009)

The threshold instruction message set includes the common data elements as listed in Table C.1 as well as the data elements depicted in Table C.2. The field numbers are a continuation of the field structure of the common data elements structure.

Table C.2 — Probe data management threshold frequency

Field 12	Field 13
Threshold	Threshold direction
	Integer
	0 = greater than
	1 = less than
Normative robe data units (ISO 22837:2009)	

The delta instruction message set includes the common data elements as listed in Table C.1 and the data elements listed in Table C.3. The field numbers are a continuation of the field table of the common data elements structure.

Table C.3 — Probe data management delta instruction

Field 12	Field 13	Field 14
Delta value	Delta direction	Time differential
	Integer	Integer
	0 = greater than	Unit = seconds
	1 = less than	Valid rule = 0 - 9999
Normative probe data units (Table 3, ISO 22837:2009) or desired percentage differential	2 = Both	

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