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Health informatics — Personal health device communication

Part 20601: Application profile — Optimized exchange protocol (ISO/IEEE 11073-20601:2010)

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The UK participation in its preparation was entrusted to Technical Committee IST/35, Health informatics.

A list of organizations represented on this committee can be obtained on request to its secretary.

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ISBN 978 0 580 68055 7

ICS 35.240.80

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 April 2011.

Amendments issued since publication

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN ISO 11073-20601

March 2011

ICS 35.240.80

English Version

Health informatics - Personal health device communication - Part 20601: Application profile - Optimized exchange protocol (ISO/IEEE 11073-20601:2010)

Informatique de santé - Communication entre dispositifs de santé personnels - Partie 20601: Profil d'application - Protocole d'échange optimisé (ISO/IEEE 11073-20601:2010)

Medizinische Informatik - Kommunikation von Geräten für die persönliche Gesundheit - Teil 20601: Anwendungsprofil - Optimiertes Datenübertragungsprotokoll (ISO/IEEE 11073-20601:2010)

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Foreword

The text of ISO/IEEE 11073-20601:2010 has been prepared by Technical Committee ISO/TC 215 “Health informatics” of the International Organization for Standardization (ISO) and has been taken over as EN ISO 11073-20601:2011 by Technical Committee CEN/TC 251 “Health informatics” the secretariat of which is held by NEN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2011, and conflicting national standards shall be withdrawn at the latest by September 2011.

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Foreword

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ISO/IEEE 11073-20601 was prepared by the 11073 Committee of the Engineering in Medicine and Biology Society of the IEEE (as IEEE Std 11073-20601-2008). It was adopted by Technical Committee ISO/TC 215, *Health informatics*, in parallel with its approval by the ISO member bodies, under the “fast-track procedure” defined in the Partner Standards Development Organization cooperation agreement between ISO and IEEE. Both parties are responsible for the maintenance of this document.

ISO/IEEE 11073 consists of the following parts, under the general title *Health informatics — Personal health device communication (text in parentheses gives a variant of subtitle)*:

— *Part 10101: (Point-of-care medical device communication) Nomenclature*

— *Part 10201: Domain information model*

— *Part 10404: Device specialization — Pulse oximeter*

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— *Part 10407: Device specialization — Blood pressure monitor*

— *Part 10408: (Point-of-care medical device communication) Device specialization — Thermometer*

— *Part 10415: (Point-of-care medical device communication) Device specialization — Weighing scale*

— *Part 10417: Device specialization — Glucose meter*

— *Part 10471: (Point-of-care medical device communication) Device specialization — Independant living activity hub*

— *Part 20101: (Point-of-care medical device communication) Application profiles — Base standard*

— *Part 20601: (Point-of-care medical device communication) Application profile — Optimized exchange protocol*

— *Part 30200: (Point-of-care medical device communication) Transport profile — Cable connected*

— *Part 30300: (Point-of-care medical device communication) Transport profile — Infrared wireless*

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Introduction

ISO and IEEE 11073 standards enable communication between medical devices and external computer systems. This standard and corresponding IEEE 11073-104zz standards address a need for a simplified and optimized communication approach for personal health devices, which may or may not be regulated devices. These standards align with, and draw upon, the existing clinically focused standards to provide easy management of data from either a clinical or personal health device.

This document addresses a need for an openly defined, independent standard for converting the collected information into an interoperable transmission format so the information can be exchanged between agents and managers.

Other closely related standards include the following:

— ISO/IEEE P11073-00103 [B8][a] provides an overview of the personal health space and defines the underlying use cases and usage models.

— ISO/IEEE 11073-10101 [B12] documents the nomenclature terms that can be used.

— ISO/IEEE 11073-10201:2004 [B13] documents the extensive domain information model (DIM) leveraged by this standard.

— ISO/IEEE 11073-104zz standards define specific device specializations. For example, ISO/IEEE P11073-10404 [B9] defines how interoperable pulse oximeters work.

— ISO/IEEE 11073-20101:2004 [B14] defines the medical device encoding rules (MDER) used in this standard.

[a] The numbers in brackets correspond to the numbers of the bibliography in Annex K.

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INTERNATIONAL STANDARD ISO/IEEE 11073-20601:2010(E)

Health informatics — Personal health device communication —

Part 20601: Application profile — Optimized exchange protocol

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1. Overview

1.1 Scope

Within the context of the ISO/IEEE 11073 family of standards for device communication, this standard defines a common framework for making an abstract model of personal health data available in transport-independent transfer syntax required to establish logical connections between systems and to provide presentation capabilities and services needed to perform communication tasks. The protocol is optimized to personal health usage requirements and leverages commonly used methods and tools wherever possible.

1.2 Purpose

This document addresses a need for an openly defined, independent standard for converting the information profile into an interoperable transmission format so the information can be exchanged to and from personal telehealth devices and compute engines (e.g., cell phones, personal computers, personal health appliances, and set top boxes).

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1.3 Context

Figure 1 shows categories and typical devices supporting the personal health space. Agents (e.g., blood pressure monitors, weighing scales, and pedometers) collect information about a person (or persons) and transfer the information to a manager (e.g., cell phone, health appliance, or personal computer) for collection, display, and possible later transmission. The manager may also forward the data to remote support services for further analysis. The information is available from a range of domains including disease management, health and fitness, or aging independently applications.

The communication path between agent and manager is assumed to be a logical point-to-point connection. Generally, an agent communicates with a single manager at any point in time. A manager may communicate with multiple agents simultaneously using separate point-to-point connections.

The overlay shows the focus area of the IEEE 11073™ Personal Health Devices Working Group. The primary concentration is the interface and data exchange between the agents and manager. However, this interface cannot be created in isolation by ignoring the remainder of the solution space. Remaining cognizant of the entire system helps to ensure that data can reasonably move from the agents all the way to the remote support services when necessary. This path may include converting the data format, exchange protocols, and transport protocols across different interfaces. Much of the standardization effort is outside of the scope of the Personal Health Devices Working Group; however, aligning all standardization efforts allows data to flow seamlessly through the overall set of systems.

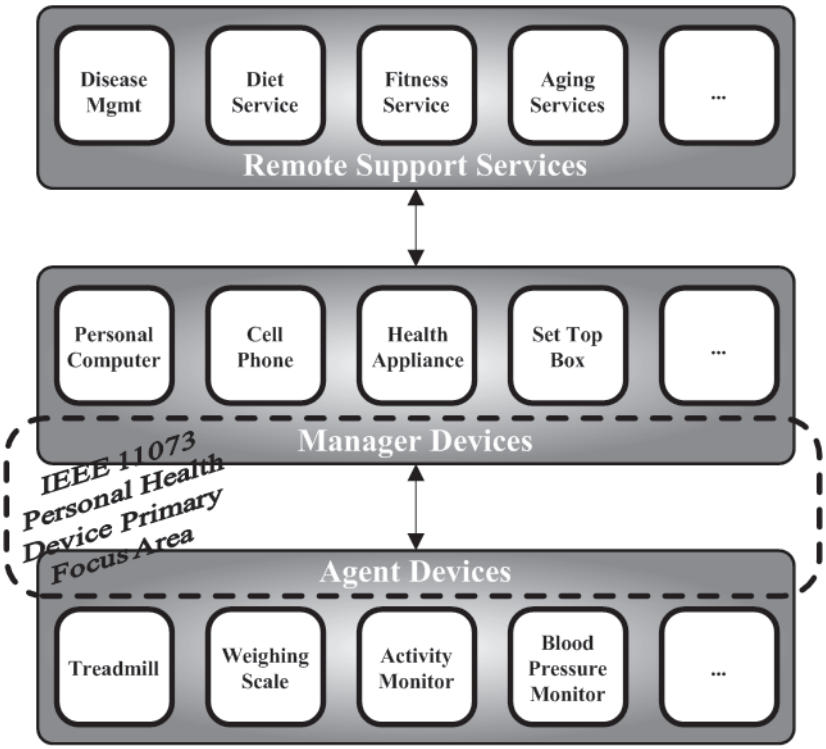

Figure 1 —Overall context of work

Figure 2 shows a hierarchical view of the architecture of an agent or manager superimposed with a view of the related standards. The application layers are, for the most part, not specific to any particular transport. Where necessary, this standard identifies assumptions that require direct support by a transport or a "shim" layer above the transport. This approach allows support for various transports. The definition of the transports is outside the scope of this standard and the working group.

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Above the transport layer is the Optimized Exchange Protocol (described in this standard). This protocol consists of two aspects: the application layer services and the definition of the data exchange protocol between agents and managers. The application layer services provide the protocol for connection management and reliable transfer of actions and data between agent and manager. The data exchange protocol defines the commands, agent configuration information, data format, and overall protocol. The Optimized Exchange Protocol provides the basis to support any type of agent. For a specific device type, the reader is directed to the device specialization for that agent to understand the capabilities of the device and its implementation according to this standard. The device specialization indicates which aspects of this standard to comprehend and where further information to implement the device is found.

Above the exchange protocol are device specializations that describe specific details relative to the particular agent (e.g., blood pressure monitor, weighing scale, or pedometer). The specializations describe the details of how these agents work and act as a detailed description for creating a specific type of agent. Additionally, they provide reference to a related standard for further details. The standard numbers reserved for device specializations range from IEEE Std 11073-10401 through IEEE Std 11073-10499, inclusive. When the collection of standards is being referenced, the term *IEEE 11073-104zz* is used where zz could be any number in the range from 01 to 99, inclusive.

The ISO/IEEE P11073-00103 [B8][1] technical report describes the overall personal health space with further definition of the underlying use cases and usage models.

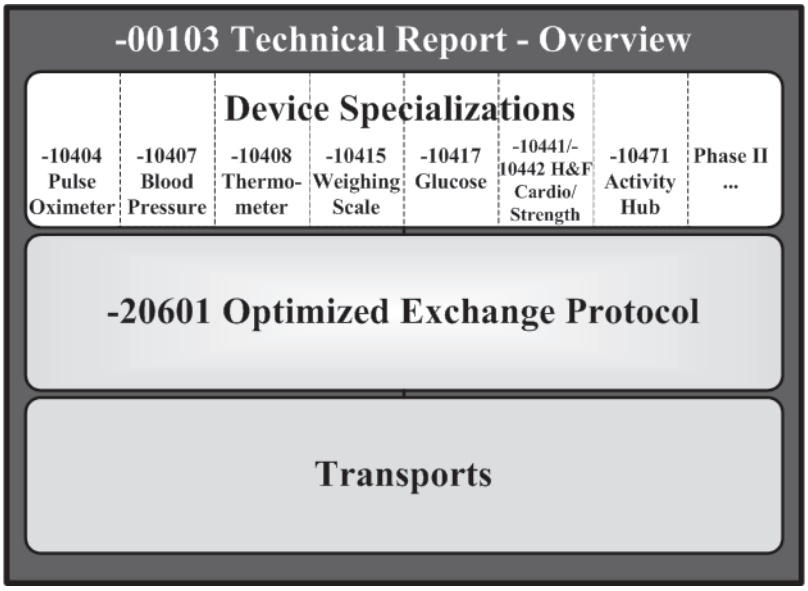

Figure 2 —Document map

The personal health device specializations are not being created independently of all other standards. There are a number of existing standards generated for clinical environments upon which these standards draw. Figure 3 shows the relationship to the remainder of the IEEE 11073 documents. There are two types of relationships:

[1] The numbers in brackets correspond to the numbers of the bibliography in Annex K.

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— Drawing ideas and/or content from the other documents (dashed lines)

— Leveraging information from the other document and introducing new content into that document to support this standard (solid lines)

This standard imports information from ISO/IEEE 11073-10201:2004 [B13] and ISO/IEEE 11073-20101:2004 [B14] as normative annexes. If there is a discrepancy between these standards, this standard takes priority. Because of the reuse of constructs from these standards, some of the names appear to be more clinically focused [e.g., medical device system (MDS) instead of personal health device system]; however, to maintain consistency, the traditional names have been preserved.

This standard replicates relevant portions of ISO/IEEE 11073-10101 [B12] and incorporates new nomenclature codes.

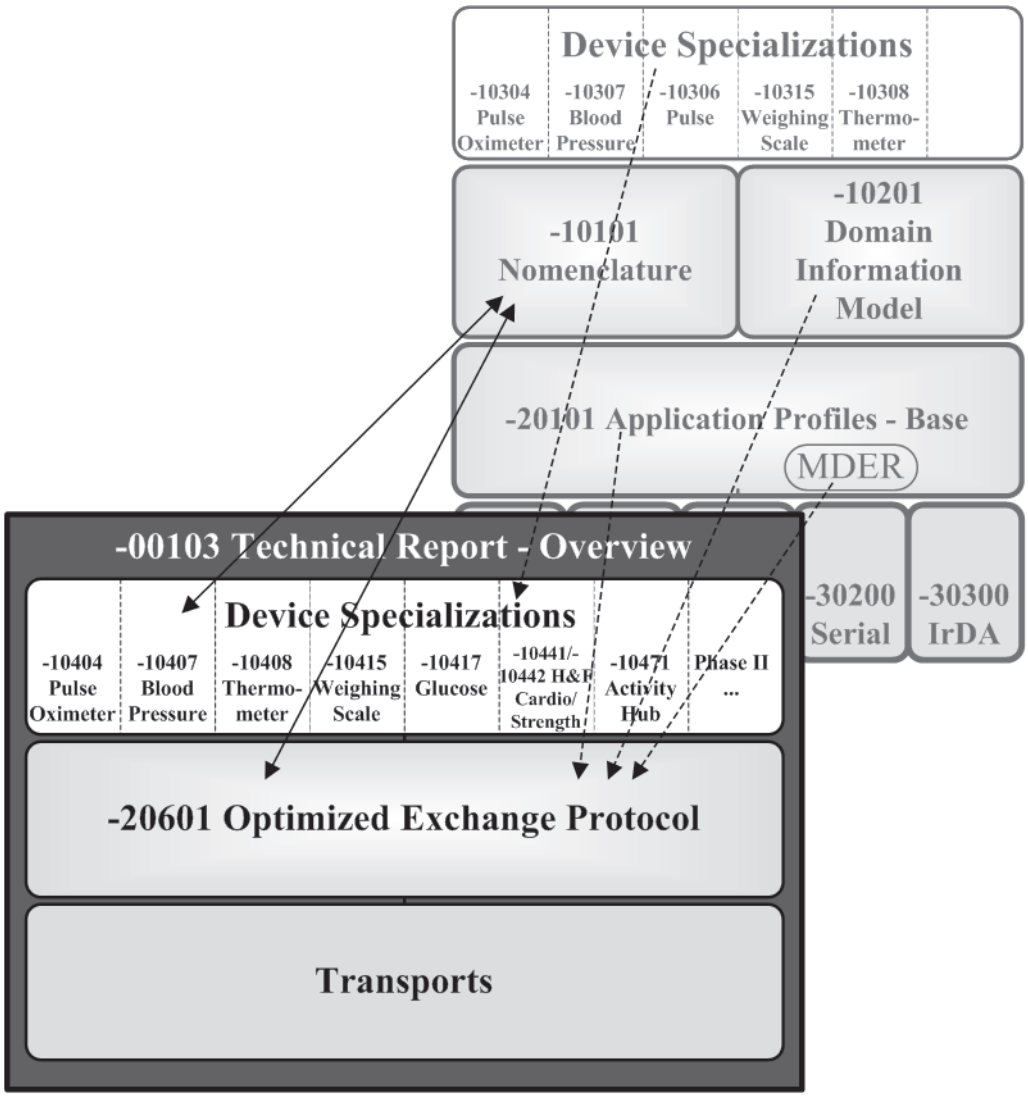

Figure 3 —Relationship to other IEEE 11073 documents

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2. Normative references

The following referenced documents are indispensable for the application of this standard (i.e., they must be understood and used; therefore, each referenced document is cited in the text and its relationship to this standard is explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

IEEE Std 802®-2001, IEEE Standard for Local and Metropolitan Area Networks: Overview and Architecture.[2]

ITU-T Rec. X.667 (Sept. 2004), Information technology – Open Systems Interconnection – Procedures for the operation of OSI Registration Authorities: Generation and registration of universally unique identifiers (UUIDs) and their use as ASN.1 object identifier components.[3]

3. Definitions, acronyms, and abbreviations

3.1 Definitions

For the purposes of this standard, the following terms and definitions apply. *The Authoritative Dictionary of IEEE Standards* [B6] should be referenced for terms not defined in this clause.

3.1.1 agent: A node that collects and transmits personal health data to an associated manager.

3.1.2 compute engine: *See:* **manager**.

3.1.3 confirmed: An application-level, completion notification service mechanism. For EVENT REPORT services (i.e., the data plane), confirmation allows the agent to know when the manager has "accepted responsibility" for a piece of data so that the agent can delete that data. For the ACTION, GET, and SET services (i.e., the control plane), confirmation allows the manager to know when the agent has "completed" the requested transaction.

3.1.4 device: A physical device implementing either an agent or manager role.

3.1.5 handle: An unsigned 16-bit number that is locally unique and identifies one of the object instances within an agent.

3.1.6 manager: A node receiving data from one or more agent systems. Examples of managers include a cellular phone, health appliance, set top box, or computer system.

3.1.7 personal health device: A device used in personal health applications.

3.1.8 personal telehealth device: *See:* **personal health device**.

3.2 Acronyms and abbreviations

ASCII	American Standard Code for Information Interchange[4]
ASN.1	Abstract Syntax Notation One
APDU	application protocol data unit

[2] IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, Piscataway, NJ 08854, USA (http://standards.ieee.org/).
[3] ITU-T publications are available from the International Telecommunications Union, Place des Nations, CH-1211, Geneva 20, Switzerland/Suisse (http://www.itu.int/).
[4] Note that throughout this standard the term ASCII is used to mean the character set as defined in ISO/IEC 646 (1991) [B7].

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AVA	attribute value assertion
BER	binary encoding rules
DIM	domain information model
EUI-64	extended unique identifier (64 bits)
GMDN	Global Medical Device Nomenclature
ICS	implementation conformance statement
ID	identifier
LSB	least significant bit
MDER	medical device encoding rules
MDNF	medical device numeric format
MDS	medical device system
MOC	medical object class
MSB	most significant bit
NaN	not a number
NBO	network byte order
NRes	not at this resolution
NTP	Network Time Protocol
OID	object identifier
OUI	organizationally unique identifier
PDU	protocol data unit
PER	packed encoding rules
POC	*personal health device domain information model* object and class
RC_{assoc}	retry count: association procedure
RTC	real-time clock
RT-SA	real-time sample array
SNTP	Simple Network Time Protocol
TCP	Transmission Control Protocol
TO_{assoc}	timeout: association procedure
TO_{ca}	timeout: confirmed action service
$TO_{cer\text{-}mds}$	timeout: confirmed event report service for the MDS object
$TO_{cer\text{-}pms}$	timeout: confirmed event report service for the PM-store object
$TO_{cer\text{-}scan}$	timeout: confirmed event report service for the scanner object
$TO_{clr\text{-}pms}$	timeout: confirmed action service to clear the PM-store object
TO_{config}	timeout: configuration procedure
TO_{cs}	timeout: confirmed set service
TO_{get}	timeout: get service
$TO_{release}$	timeout: association release procedure
$TO_{sp\text{-}mds}$	timeout: special interservice timeout for the MDS object
$TO_{sp\text{-}pms}$	timeout: special segment transfer timeout for the PM-segment object
UTC	universal time coordinated
UUID	universally unique identifier
USB	universal serial bus
XER	Extensible Markup Language (XML) encoding rules

4. Guiding principles

This standard and the other personal health device standards fit in the larger context of the ISO/IEEE 11073 family of standards. The full suite of standards enables agents to interconnect and interoperate with managers and with computerized healthcare information systems.

The communication profile defined in this standard takes into account the specific requirements of personal health agents and managers, which are typically used outside a clinical setting, e.g., mobile or in a person's home:

— Personal health agents typically have very limited computing capabilities.

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— Personal health agents typically have a fixed configuration, and they are used with a single manager device.

— Personal health agents are frequently battery powered, mobile devices, using a wireless communication link. Therefore, energy efficiency of the protocol is an important aspect.

— Personal health agents are often not permanently active. For example, a weighing scale may provide data only once or twice a day. An efficient connection procedure is needed for minimum overhead for such devices.

— Personal health managers tend to have more processing power, memory, and storage space so the protocol intentionally places more load on the managers.

— Personal health agents and managers convey information that could be useful to clinical professionals. As such, the quality of the data may be considered to have clinical merit even if acquired in a personal health or remote monitoring environment.

The ISO/IEEE 11073 family of standards is based on an object-oriented systems management paradigm. Data (measurement, state, and so on) are modeled in the form of information objects that are accessed and manipulated using an object access service protocol.

To address the unique requirements of personal health devices, a specialized application profile is defined in this standard. This profile leverages concepts from the ISO/IEEE 11073 family of standards and industry best practices to define an optimized communication profile for this domain:

— Where possible, the communication profile is not specific to any particular transport.

— The information model of the communication profile is built on the ISO/IEEE 11073 domain information model (DIM) and includes optimizations where possible.

— An optimized communication protocol is defined to reduce message size, run-time packet construction, and parsing overheads. This is possible due to the lower complexity of the devices in the personal health domain.

— Required definitions for a protocol implementation are included in this standard, rather than referenced. This approach facilitates easier adoption of this standard. In the case of discrepancies between the normative inclusions and a referenced document, this standard takes precedence.

Where possible, versions of this standard are fully backward compatible with at least two major versions.

NOTE—It is expected that any new additions to the DIM or other relevant parts of the ISO/IEEE 11073 family of standards will be adopted and reflected in future revisions of those standards.[5]

5. Introduction to IEEE 11073 personal health devices

5.1 General

The overall ISO/IEEE 11073 system model is divided into three principal components: the DIM, the service model, and the communications model. These three models work together to represent data, define data access and command methodologies, and communicate the data from an agent to a manager. Because of the tight relationship between the models, the DIM, service model, and communications model are briefly introduced in 5.2, 5.3, and 5.4, respectively, so that when they are described in more detail, in Clause 6, Clause 7, and Clause 8, respectively, the basic concepts are familiar.

[5] Notes in text, tables, and figures of a standard are given for information only and do not contain requirements needed to implement the standard.

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5.2 Domain information model (DIM)

The DIM, described in detail in Clause 6, characterizes information from an agent as a set of objects. Each object has one or more attributes. Attributes describe measurement data that are communicated to a manager as well as elements that control behavior and report on the status of the agent.

5.3 Service model

The service model, described in detail in Clause 7, provides data access primitives that are sent between the agent and manager to exchange data from the DIM. These primitives include commands such as Get, Set, Action, and Event Report.

5.4 Communication model

The communication model, described in detail in Clause 8, supports the topology of one or more agents communicating over point-to-point connections to a single manager. For each point-to-point connection, the dynamic system behavior is defined by a connection state machine. The connection state machine defines the states and substates an agent and manager pair passes through, including states related to connection, association, and operation. The communication model also defines in detail the entry, exit, and error conditions for the respective states including various operating procedures for measurement data transmission. The communication model also includes assumptions regarding the underlying communication layers' behavior.

Another function of the communication model is to convert the abstract data modeling (abstract syntax) used in the DIM into a transfer syntax, for example, to binary messages using medical device encoding rules (MDER), that are sent using the communication model.

6. Personal health device DIM

6.1 General

Personal health devices, within this standard, are defined using an object-oriented model. This DIM defines several classes for modeling an agent. The model describes an agent device as a set of objects that represent the data sources, as the elements that a manager can use to control the behavior of the agent, and as the mechanism the agent uses to report updates to the status of agent representation. Agent device objects have attributes that represent information and status for the object.

Manager devices communicate with agent device objects through the use of well-defined methods, such as GET and SET, and are defined in each subclause describing an object. Information, such as measurements, is sent from agent data objects to the manager device using event reports.

The information model for the domain of personal health devices is an object-oriented model defining data objects of agents, including their attributes and methods. The use of an object-oriented information model supports the following:

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— Separation of specification from implementation through the principle of encapsulation

— Support for evolution through the principle of inheritance

— Support for backward compatibility through the principle of polymorphism

The objects derived from classes defined in the information model represent all data that an agent system can communicate to a manager system by means of the application protocol defined in this standard. Such data are modeled in the form of object attributes. Furthermore, the information model defines specific data access services in the form of methods that are used for data exchange between agent and manager systems. These services model the application protocol messages (data access primitives) defined in this standard.

Objects define the structure and the capabilities of the agent system. The manager system accesses these objects to retrieve data and/or to control the agent system. This standard does not define an information model of the manager system.

The information model is a hierarchical model that defines the logical structure and capability of a personal health device. At a top level, the MDS object represents the properties and services of the device itself, independent of its health data capabilities. Properties of the MDS object include attributes for device identification and further technical descriptive and state data. The application-specific data (e.g., health data and measurement data) provided by the personal health device are modeled in the form of further information objects that are logically contained in the MDS object. The set of object attributes, together with this containment relation, describes the configuration and, as such, the capabilities of the personal health device.

Note that while the definitions in this standard make use of object orientation to define the information model, this practice does not imply use of object-oriented technologies (e.g., object-oriented programming languages) for the implementation of this standard in a particular device. The model is used to define data structures and access methods (protocol messages) in a consistent and maintainable way. Conformance to these definitions is at a communication protocol message level only. Specifically, definitions in this standard are optimized to allow very simple agent implementations (e.g., by use of pre-defined transmission templates). Likewise, the implementation of the manager device is free to choose a design that makes use of the information objects versus other design alternatives.

This standard makes use of information classes and objects that are defined in ISO/IEEE 11073-10201:2004 [B13], but adapts these to the domain of personal health device communication in the following ways:

— The definition of attributes that are mandatory, optional, or conditional may be different.

— Additional object services may be defined.

— Additional attributes may be defined.

— Some features of the original model might not be used.

6.2 Nomenclature usage

A key aspect of the DIM is that object classes and attributes are referenced using nomenclature codes found in ISO/IEEE 11073-10101 [B12]. By using a consistent nomenclature, interoperability is enhanced as all implementations maintain the same semantic meaning for the numeric codes. Using nomenclature codes also assists with international implementations as the use of strings is reduced.

The ISO/IEEE 11073 nomenclature is defined as a set of context-dependent partitions. The nomenclature code in each context-dependent partition is defined by a 16-bit code that supports up to 65 536 independent terms per partition. The partitions are referenced by a 16-bit partition code. When the partition of the nomenclature code is defined through context, then it is possible to use only the 16-bit term code. If the context is not defined or a context-independent term code is required, then this situation is specified by a

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32-bit code constructed from the 16-bit partition code together with the 16-bit term code. Table 1 shows the partitions that are defined in this standard and/or ISO/IEEE 11073-10101 [B12].

Term codes from 0xF000 – 0xFFFF in each partition in the nomenclature are reserved for private (vendor-specified) nomenclature codes.

For each nomenclature term, ISO/IEEE 11073-10101 [B12] defines a systematic name that explains the term, a unique code value, and a reference identifier (ID). The reference ID has the form MDC_XXX_YYY (with MDC referring to "medical device communication"). Throughout this standard, nomenclature terms and nomenclature codes are referenced by the reference ID.

Table 1—Partitions in the nomenclature

Partition number	Nomenclature category
1	Object-oriented (OO)
2	Supervisory control and data acquisition (SCADA)
3	Events
4	Dimensions (units of measurement)
5	Virtual attributes
6	Parameter groups
7	[Body] sites
8	Infrastructure
9–127	Reserved
128	Personal health devices disease management
129	Personal health devices health and fitness
130	Personal health devices aging independently
131–254	Reserved
255	Return codes
256	External nomenclature references
257–1023	Reserved
1024	Private
1025–65 535	Reserved

6.3 Personal health object class definitions

6.3.1 General

The diagram in Figure 4 uses Unified Modeling Language (UML) to represent the information objects of a personal health agent along with class relationships. The top-most object represents the MDS information and its status (see 6.3.2). There are zero or more numeric, real-time sample array (RT-SA), enumeration, scanner, or PM-store objects associated with an MDS object. There are zero or more PM-segments that contain persistent metrics associated with a PM-store. Numeric, RT-SA, and enumeration are derived from a common metric base class that contains common and shared attributes (see 6.3.3). In general, numeric objects represent episodic measurements (see 6.3.4), RT-SA objects represent continuous samples or wave forms (see 6.3.5), enumeration objects represent event annotations (see 6.3.6), and PM-stores (see 6.3.7) along with PM-segments (see 6.3.8) provide a persistent storage mechanism for metrics that are accessed by the manager at a later time. In addition, a scanner object (further defined in 6.3.9) facilitates the reporting of agent-initiated data transfers.

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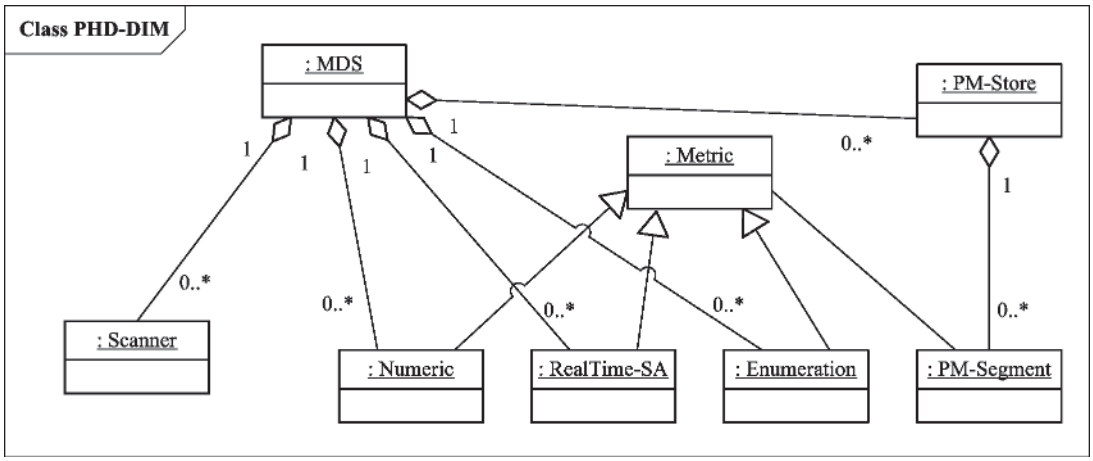

Figure 4 —Personal health device – DIM

Subclauses 6.3.2 through 6.3.9 describe the classes of the personal health device DIM. Each subclause uses the following format:

— The nomenclature code used to identify the class. This code is used during the configuration event to report the class for each object and allows the manager to learn whether the object being specified is numeric, RT-SA, or any of the other classes.

— The attributes defined by the class.

— The methods available.

— The potential events generated by objects instantiated from the class.

— The available services such as getting or setting attributes.

Each attribute data type is defined using an Abstract Syntax Notation One (ASN.1). The ASN.1 definitions for all data types and exchange formats are found in Annex A.

The attributes for each class are defined in tables that specify the name of the attribute, its nomenclature reference ID, its type, a description of the attribute, and its qualifier. The qualifiers mean O — Attribute is Optional, M — Attribute is Mandatory, and C — Attribute is Conditional and depends on the condition stated in the Remark column. Optional attributes may be implemented on an agent. Mandatory attributes shall be implemented by an agent. Conditional attributes shall be implemented if the condition applies and may be implemented otherwise.

The nomenclature code of the object class (e.g., numeric, RT-SA) is sent to the manager at configuration time to create a mirrored object representation. Each object has a Handle attribute that is used to identify the object for operations (to or from the object) and other attributes to represent and convey information on the physical device and its data sources. Attributes are accessed and modified using methods such as GET and SET. Data are transmitted using EVENTs.

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6.3.2 MDS class

6.3.2.1 General

Each personal health device agent is defined by an object-oriented model as shown in Figure 4. The top-level object of each agent is instantiated from the MDS class. Each agent has one MDS object. The MDS represents the identification and status of the agent through its attributes.

6.3.2.2 MDS class identification

The nomenclature code to identify the MDS class is MDC_MOC_VMS_MDS_SIMP.

6.3.2.3 MDS class attributes

Table 2 defines the set of MDS attributes that are supported for personal health agent communication. An MDS object shall support all mandatory attributes, but may have a subset of the conditional and optional attributes present.

Table 2—MDS attributes

Attribute name	Attribute ID	Attribute type	Remark	Qual.
Handle	MDC_ATTR_ID_ HANDLE	HANDLE	The Handle attribute represents a reference ID for this object. The value of the MDS Handle attribute shall be 0.	M
System-Type	MDC_ATTR_SYS_TYPE	TYPE	This attribute defines the type of the agent, as defined in nomenclature (e.g., weighing scale). The values shall come from ISO/IEEE 11073-10101 [B12], nom-part-object partition, and subpartition MD-Gen (Medical Device – Generic). Either this attribute or System-Type-Spec-List shall be present. This attribute shall remain unchanged after the configuration is agreed upon.	C
System-Model	MDC_ATTR_ID_MODEL	SystemModel	This attribute defines manufacturer and model number of the agent device. This attribute shall remain unchanged after the configuration is agreed upon.	M

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Table 2—MDS attributes

Attribute name	Attribute ID	Attribute type	Remark	Qual.
System-Id	MDC_ATTR_SYS_ID	OCTET STRING	This attribute is an IEEE EUI-64, which consists of a 24-bit unique organizationally unique identifier (OUI) followed by a 40-bit manufacturer-defined ID. The OUI shall be a value assigned by the IEEE Registration Authority (http://standards.ieee.org/regauth/index.html) and shall be used in accordance with IEEE Std 802-2001.[6] This attribute shall remain unchanged after the configuration is agreed upon.	M
Dev-Configuration-Id	MDC_ATTR_DEV_CONFIG_ID	ConfigId	This attribute defines the identification of the agent device configuration. This Dev-Configuration-Id is static during the lifetime of an association; it is normally exchanged during the association procedure. The manager can GET this attribute during operation. If this attribute is queried prior to when the agent and manager agree upon a configuration, the agent shall return the configuration ID that is being offered at that time. For more information on this attribute, see 8.7.6. This attribute shall remain unchanged after the configuration is agreed upon.	M
Attribute-Value-Map	MDC_ATTR_ATTRIBUTE_VAL_MAP	AttrValMap	This attribute defines the attributes that are reported in the fixed format data update messages (see 7.4.5 for more information). Usage of this attribute is mandatory if the agent device uses fixed format value messages to report dynamic data for the object.	C
Production-Specification	MDC_ATTR_ID_PROD_SPECN	ProductionSpec	This attribute defines component revisions, serial numbers, and so on in a manufacturer-specific format. This attribute shall remain unchanged after the configuration is agreed upon.	O
Mds-Time-Info	MDC_ATTR_MDS_TIME_INFO	MdsTimeInfo	This attribute defines the time handling capabilities and the status of the MDS. Usage of this attribute is required if synchronization or settable time is supported.	C

[6] For information on references, see Clause 2.

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Table 2—MDS attributes

Attribute name	Attribute ID	Attribute type	Remark	Qual.
Date-and-Time	MDC_ATTR_TIME_ABS	AbsoluteTime	This attribute defines the date and time of an agent with resolution of 1/100 of a second, if available. For more information on this attribute, see 8.12. If the agent reports AbsoluteTime in any other message, it shall report its current value of AbsoluteTime in this attribute.	C
Relative-Time	MDC_ATTR_TIME_REL	RelativeTime	If the agent reports RelativeTime in any other message, it shall report its current value of RelativeTime in this attribute.	C
HiRes-Relative-Time	MDC_ATTR_TIME_REL_HI_RES	HighResRelativeTime	If the agent reports HighResRelativeTime in any other message, it shall report its current value of HighResRelativeTime in this attribute.	C
Date-and-Time-Adjustment	MDC_ATTR_TIME_ABS_ADJUST	AbsoluteTimeAdjust	This attribute reports any date and time adjustments that occur either due to a person's changing the clock or events such as daylight savings time. This is used in event reports only. If queried with Get MDS Object command, this value shall be not present or 0. If the agent ever adjusts the date and time, this attribute is used in an event report to report such adjustment.	C
Power-Status	MDC_ATTR_POWER_STAT	PowerStatus	This attribute reports whether power is being drawn from battery or main power lines and the status of charging.	O
Battery-Level	MDC_ATTR_VAL_BATT_CHARGE	INT-U16	This attribute reports the percentage of battery capacity remaining, which is undefined if value > 100.	O
Remaining-Battery-Time	MDC_ATTR_TIME_BATT_REMAIN	BatMeasure	This attribute represents the predicted amount of operational time left on the batteries. The BatMeasure's unit shall be set to one of MDC_DIM_MIN, MDC_DIM_HR, or MDC_DIM_DAY for minutes, hours, or days, respectively.	O

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Table 2—MDS attributes

Attribute name	Attribute ID	Attribute type	Remark	Qual.
Reg-Cert-Data-List	MDC_ATTR_REG_CERT_DATA_LIST	RegCertDataList	This attribute lists various regulatory and/or certification compliance items to which the agent claims adherence as an informative statement. The Implementation Conformace Statements (see Clause 9) take precedence over this attribute and are the legally binding claims. This attribute shall remain unchanged after the configuration is agreed upon.	O
System-Type-Spec-List	MDC_ATTR_SYS_TYPE_SPEC_LIST	TypeVerList	This attribute reports the type(s) of the agent, as defined in nomenclature (e.g., weighing scale). The values shall come from ISO/IEEE 11073-10101 [B12], nom-part-infrastruct partition, subpartition DEVspec, and reference ISO/IEEE 11073-104zz specializations. If an agent does not follow any specialization, the list shall be left blank. This list shall also contain the version of the specialization. Either this attribute or System-Type shall be present. If the agent is multifunction, this attribute shall be present. This attribute shall remain unchanged after the configuration is agreed upon.	C
Confirm-Timeout	MDC_ATTR_CONFIRM_TIMEOUT	RelativeTime	This informational timeout attribute defines the minimum time that the agent shall wait for a Response message from the manager after issuing a Confirmed Event Report invoke message before timing out and transitioning to the Unassociated state. This is an informational attribute for the benefit of the manager. If this attribute is supplied, it shall match the actual timeout value that the agent uses for the Confirmed Event Report generated from the MDS object. This attribute is informational for the manager in the sense that the manager does not use this attribute in an actual implementation of the protocol (i.e., the manager does not time out on an agent-generated Confirmed Event Report).	O

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Table 2—MDS attributes

Attribute name	Attribute ID	Attribute type	Remark	Qual.
			However, the manager might wish to use this information to prioritize its handling of a "short" timeout agent over that of a "long" timeout agent.	

The attribute data types are defined in Annex A.

6.3.2.4 MDS object methods

Table 3 defines the methods (actions) available for the MDS object. These methods are invoked using the ACTION service. In Table 3, the Method/Action column defines the name of the method. The Mode column defines whether the method is invoked as an unconfirmed action (i.e., roiv-cmip-action from A.10.2) or a confirmed action (i.e., roiv-cmip-confirmed-action). The Action-type column defines the nomenclature ID to use in the action-type field of an action request and response (see A.10.6). The action-info-args column defines the associated data structure to use in the action message for the action-info-args field of the request. The Resulting action-info-args column defines the structure to use in the action-info-args of the response.

Table 3—MDS object methods

Method/Action	Mode	Action-type	action-info-args	Resulting action-info-args
MDS-Data-Request	Confirmed	MDC_ACT_DATA_REQUEST	DataRequest	DataResponse
Set-Time	Confirmed	MDC_ACT_SET_TIME	SetTimeInvoke	None

— **MDS-Data-Request:**
This method allows the manager system to enable or disable measurement data transmission from the agent (see 8.9.3.3.3 for a description).

— **Set-Time:**
This method allows the manager system to set a real-time clock (RTC) with the absolute time. The agent indicates whether the Set-Time command is valid by using the mds-time-capab-set-clock bit in the Mds-Time-Info attribute (see Table 2).

6.3.2.5 MDS object events

Table 4 defines the potential events sent by the MDS object. A manager shall support all methods defined in Table 4.

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Table 4—MDS object events

Event	Mode	Event-type	Event-info parameter	Event-reply-info
MDS-Configuration-Event	Confirmed or unconfirmed	MDC_NOTI_CONFIG	ConfigReport	ConfigReportRsp
MDS-Dynamic-Data-Update-Var	Confirmed or unconfirmed	MDC_NOTI_SCAN_REPORT_VAR	ScanReportInfoVar	-
MDS-Dynamic-Data-Update-Fixed	Confirmed or unconfirmed	MDC_NOTI_SCAN_REPORT_FIXED	ScanReportInfoFixed	-
MDS-Dynamic-Data-Update-MP-Var	Confirmed or unconfirmed	MDC_NOTI_SCAN_REPORT_MP_VAR	ScanReportInfoMPVar	-
MDS-Dynamic-Data-Update-MP-Fixed	Confirmed or unconfirmed	MDC_NOTI_SCAN_REPORT_MP_FIXED	ScanReportInfoMPFixed	-

— **MDS-Configuration-Event:**
This event is sent by the agent during the configuring state of startup if the manager does not already know the agent's configuration from past associations. The event provides static information about the supported measurement capabilities of the agent.

— **MDS-Dynamic-Data-Update-Var:**
This event provides dynamic data (typically measurements) from the agent for some or all of the objects that the agent supports. Data for reported objects are reported using a generic attribute list variable format (see 7.4.5 for details on event report formats). The event is triggered by an MDS-Data-Request from the manager system, or it is sent as an unsolicited message by the agent. For agents that support manager-initiated measurement data transmission, refer to 8.9.3.3.3 for information on controlling the activation and/or period of the data transmission. For agents that do not support manager-initiated measurement data transmission, refer to 8.9.3.3.2 for information on the limited control a manager can assert.

— **MDS-Dynamic-Data-Update-Fixed:**
This event provides dynamic data (typically measurements) from the agent for some or all of the metric objects or the MDS object that the agent supports. Data are reported in the fixed format defined by the Attribute-Value-Map attribute for reported metric objects or the MDS object (see 7.4.5 for details on event report formats). The event is triggered by an MDS-Data-Request from the manager system (i.e., a manager-initiated measurement data transmission), or it is sent as an unsolicited message by the agent (i.e., an agent-initiated measurement data transmission). For agents that support manager-initiated measurement data transmission, refer to 8.9.3.3.3 for information on controlling the activation and/or period of the data transmission. For agents that do not support manager-initiated measurement data transmission, refer to 8.9.3.3.2 for information on the limited control a manager can assert.

— **MDS-Dynamic-Data-Update-MP-Var:**
This is the same as MDS-Dynamic-Data-Update-Var, but allows inclusion of data from multiple persons.

— **MDS-Dynamic-Data-Update-MP-Fixed:**
This is the same as MDS-Dynamic-Data-Update-Fixed, but allows inclusion of data from multiple persons.

6.3.2.6 Other MDS services

6.3.2.6.1 GET service

Any agent supporting two-way communication links shall support the GET service to retrieve the values of all implemented MDS object attributes. The GET service can be invoked as soon as the agent receives the Association Response and moves to the Associated state, including the Operating and Configuring substates.

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The manager may request the MDS object attributes of the agent in which case the manager shall send the "Remote Operation Invoke | Get" command (see roiv-cmip-get in A.10.2) with the reserved handle value of 0. The agent shall respond by reporting its MDS object attributes to the manager using the "Remote Operation Response | Get" response (see rors-cmip-get in A.10.2). In the response to a Get MDS Object command, only attributes implemented by the agent are returned.

6.3.2.6.2 SET service

There are currently no settable attributes.

6.3.3 Metric class

6.3.3.1 General

The metric class is the base class for all objects representing measurements, status, and context data. The metric class is not instantiated; therefore, it is never part of the agent configuration. As a base class, it defines all attributes, methods, events, and services that are common for all objects representing measurements.

6.3.3.2 Metric class identification

The nomenclature code to identify the metric class is MDC_MOC_VMO_METRIC. This nomenclature code is not used in an agent or a manager implementation as the metric class is just a base class for other classes.

6.3.3.3 Metric class attributes

Table 5 defines the set of metric attributes that are supported for personal health device communication and that are inherited by all metric-derived classes.

Table 5—Metric attributes

Attribute name	Attribute ID	Attribute type	Remark	Qual.
Handle	MDC_ATTR_ID_HANDLE	HANDLE	The Handle attribute represents a reference ID for this object. Each object shall have a unique ID assigned by the agent. The handle identifies the object in event reports sent to the manager. This attribute shall remain unchanged after the configuration is agreed upon.	M
Type	MDC_ATTR_ID_TYPE	TYPE	This attribute defines a specific static type of this object as defined in the nomenclature (e.g., pulse rate for a specific numeric object instance). The Type attribute contains the nomenclature partition and term code IDs for context-free, extensible identification. This attribute shall remain unchanged after the configuration is agreed upon.	M

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Table 5—Metric attributes

Attribute name	Attribute ID	Attribute type	Remark	Qual.
Supplemental-Types	MDC_ATTR_ SUPPLEMENTAL_TYPES	SupplementalTypeList	This attribute may be used to convey supplemental information about the object beyond the Type and Metric-Id attributes. Supplemental information covers conditions like the location of the sensor or the rate at which the object reacts to changes. Device specializations define the expected usage of this attribute. For example, IEEE Std 11073-10471 [B5] defines location nomenclature for specifying the location of a sensor in a home and ISO/IEEE P11073-10404 [B9] defines three supplemental types for fast response, slow response, and spot checking of the pulse rate or blood oxygenation. This attribute shall remain unchanged after the configuration is agreed upon.	O
Metric-Spec-Small	MDC_ATTR_METRIC_SPEC_ SMALL	MetricSpecSmall	This attribute describes the characteristics of the measurements.	M
Metric-Structure-Small	MDC_ATTR_METRIC_ STRUCT_SMALL	MetricStructureSmall	This attribute describes the structure of the measurement. If not present, the manager shall assume MetricStructureSmall := {ms-struct-simple, 0}.	O
Measurement-Status	MDC_ATTR_MSMT_STAT	MeasurementStatus	This attribute indicates the validity of a particular value or set of samples.	O

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Table 5—Metric attributes

Attribute name	Attribute ID	Attribute type	Remark	Qual.
Metric-Id	MDC_ATTR_ID_PHYSIO	OID-Type	This attribute may be used to hold an identification that is more specific than the generic ID in the Type attribute. If the Metric-Id-Partition attribute is valued, it defines the nomenclature partition for this attribute. Otherwise, the OID-Type is taken from the same nomenclature partition as defined in the partition field of the Type attribute. This attribute is needed only if identification changes during operation and the Type attribute does not contain full identification. For example, if the Type attribute contains a generic temperature code (MDC_TEMP), this attribute could report a specific, but changing, identification such as MDC_TEMP_ORAL or MDC_TEMP_RECT. Only one attribute of Metric-Id and Metric-Id-List shall be present.	O
Metric-Id-List	MDC_ATTR_ID_PHYSIO_ LIST	MetricIdList	This attribute shall be used if a compound observed value is used and does not incorporate the Metric-Id directly (e.g., Compound-Simple-Nu-Observed-Value or Compound-Basic-Nu-Observed-Value) so that elements in the observed value list can be identified individually. The order of the Metric-Id-List shall correspond to the order of the elements in the compound observed value. Only one attribute of Metric-Id and Metric-Id-List shall be present.	C
Metric-Id-Partition	MDC_ATTR_METRIC_ID_ PART	NomPartition	This attribute may be used to define the partition from which the Metric-Id or Metric-Id-List nomenclature terms were taken. If not present, the partition is the same as the nomenclature partition defined in the partition field of the Type attribute.	O
Unit-Code	MDC_ATTR_UNIT_CODE	OID-Type	This attribute defines the nomenclature code for the units of measure from the nom-part-dim partition (e.g., MDC_DIM_KILO_G).	O

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Table 5—Metric attributes

Attribute name	Attribute ID	Attribute type	Remark	Qual.
Attribute-Value-Map	MDC_ATTR_ATTRIBUTE_VAL_MAP	AttrValMap	This attribute defines the attributes that are reported in the fixed format data update messages. Usage of this attribute is mandatory if the agent uses fixed format value messages to report dynamic measurement data for the object.	C
Source-Handle-Reference	MDC_ATTR_SOURCE_HANDLE_REF	HANDLE	This attribute establishes a relation of this object instance to a source object (e.g., pulse references sourcing SpO2). This attribute is used whenever it is required to model an explicit relation between object instances to define dependencies. The usage of this attribute is defined by device specializations.	O
Label-String	MDC_ATTR_ID_LABEL_STRING	OCTET STRING	This attribute defines the textual representation of Type attribute in printable ASCII. The value of this attribute is at the complete discretion of the agent's manufacturer. It could potentially be useful for a manager as a display string or as an aid in deciding how to behave when it does not understand the MDC_ATTR_ID_TYPE as reported by the agent.	O
Unit-LabelString	MDC_ATTR_UNIT_LABEL_STRING	OCTET STRING	This attribute defines the textual representation of Unit-Code dimension in printable ASCII. The value of this attribute is at the complete discretion of the agent's manufacturer. It could potentially be useful for a manager as a display string or as an aid in deciding how to behave when it does not understand the MDC_ATTR_UNIT_CODE as reported by the agent.	O

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Table 5—Metric attributes

Attribute name	Attribute ID	Attribute type	Remark	Qual.
Absolute-Time-Stamp	MDC_ATTR_TIME_STAMP_ABS	AbsoluteTime	This attribute defines the date and time of observation with resolution of 1/100 of a second, if available. For more information on this attribute, see 8.12. If an agent stores data (either in a PM-store object or as a "temporarily stored measurement"), it shall associate a time stamp (Absolute-Time-Stamp, Relative-Time-Stamp, or HiRes-Time-Stamp) with the data.	C
Relative-Time-Stamp	MDC_ATTR_TIME_STAMP_REL	RelativeTime	This attribute defines the time of observation (time stamp in a relative time format/number of clock ticks as defined by RelativeTime data type). If an agent stores data, it shall associate a time stamp (Absolute-Time-Stamp, Relative-Time-Stamp, or HiRes-Time-Stamp) with the data.	C
HiRes-Time-Stamp	MDC_ATTR_TIME_STAMP_REL_HI_RES	HighResRelativeTime	This attribute defines the time of observation (time stamp in a high-resolution relative time format/number of clock ticks as defined by a HighResRelativeTime data type). If an agent stores data, it shall associate a time stamp (Absolute-Time-Stamp, Relative-Time-Stamp, or HiRes-Time-Stamp) with the data.	C
Measure-Active-Period	MDC_ATTR_TIME_PD_MSMT_ACTIVE	FLOAT-Type	This attribute defines the time duration of the observation period in seconds.	O

6.3.3.4 Metric object methods

None

6.3.3.5 Metric object events

Objects that derive from the metric class do not report their observations directly; rather, the observations are reported through another object, such as the MDS object, a scanner object, or a PM-store object.

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6.3.3.6 Other metric services

None

6.3.4 Numeric class

6.3.4.1 General

An instance of the numeric class represents a numerical measurement. The values of a numeric object are sent from the agent to the manager using the EVENT REPORT service (see 7.3). This class is derived from the metric base class.

6.3.4.2 Numeric class identification

The nomenclature code to identify the numeric class is MDC_MOC_VMO_METRIC_NU.

6.3.4.3 Numeric class attributes

Table 6 defines the set of numeric attributes that are supported for personal health device communication.

Table 6—Numeric attributes

Attribute name	Attribute ID	Attribute type	Remark	Qual.
Simple-Nu-Observed-Value	MDC_ATTR_NU_VAL_OBS_SIMP	SimpleNuObsValue	This attribute defines the numerical observed value of the object, without any further embedded status information as found in Nu-Observed-Value. One of Simple-Nu-Observed-Value, Basic-Nu-Observed-Value, Nu-Observed-Value, Compond-Nu-Observed-Value, Compound-Simple-Nu-Observed-Value, or Compound-Basic-Nu-Observed-Value shall be present.	C
Compound-Simple-Nu-Observed-Value	MDC_ATTR_NU_CMPD_VAL_OBS_SIMP	SimpleNuObsValueCmp	This attribute represents an array of Simple-Nu-Observed-Values. One of Simple-Nu-Observed-Value, Basic-Nu-Observed-Value, Nu-Observed-Value, Compond-Nu-Observed-Value, Compound-Simple-Nu-Observed-Value, or Compound-Basic-Nu-Observed-Value shall be present.	C

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Table 6—Numeric attributes

Attribute name	Attribute ID	Attribute type	Remark	Qual.
Basic-Nu-Observed-Value	MDC_ATTR_NU_VAL_OBS_BASIC	BasicNuObsValue	This attribute defines the numerical observed value of the object, without any further embedded status information, but with a smaller numerical representation compared to Simple-Nu-Observed-Value. One of Simple-Nu-Observed-Value, Basic-Nu-Observed-Value, Nu-Observed-Value, Compond-Nu-Observed-Value, Compound-Simple-Nu-Observed-Value, or Compound-Basic-Nu-Observed-Value shall be present.	C
Compound-Basic-Nu-Observed-Value	MDC_ATTR_NU_CMPD_VAL_OBS_BASIC	BasicNuObsValueCmp	This attribute represents an array of Basic-Nu-Observed-Values. One of Simple-Nu-Observed-Value, Basic-Nu-Observed-Value, Nu-Observed-Value, Compond-Nu-Observed-Value, Compound-Simple-Nu-Observed-Value, or Compound-Basic-Nu-Observed-Value shall be present.	C
Nu-Observed-Value	MDC_ATTR_NU_VAL_OBS	NuObsValue	This attribute defines the numerical observed value of the object and combines it with measurement status and unit information. It is used when status/unit are dynamic and are always provided together with the value. One of Simple-Nu-Observed-Value, Basic-Nu-Observed-Value, Nu-Observed-Value, Compond-Nu-Observed-Value, Compound-Simple-Nu-Observed-Value, or Compound-Basic-Nu-Observed-Value shall be present.	C

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Table 6—Numeric attributes

Attribute name	Attribute ID	Attribute type	Remark	Qual.
Compound-Nu-Observed-Value	MDC_ATTR_NU_CMPD_VAL_OBS	NuObsValueCmp	This attribute combines an array of value, status, and unit. This attribute is available for use only in variable format event reports. One of Simple-Nu-Observed-Value, Basic-Nu-Observed-Value, Nu-Observed-Value, Compond-Nu-Observed-Value, Compound-Simple-Nu-Observed-Value, or Compound-Basic-Nu-Observed-Value shall be present.	C
Accuracy	MDC_ATTR_NU_ACCUR_MSMT	FLOAT-Type	This attribute defines the maximum deviation of actual value from reported observed value (if it can be specified). This attribute shall remain unchanged after the configuration is agreed upon.	O

The attributes Compound-Simple-Nu-Obs-Value, Compound-Basic-Nu-Obs-Value, and Compound-Nu-Observed-Value represent a list concept for observed values. This concept should be used whenever a strong relationship between the individual observed values is given, which might be nomenclature and/or application dependent. The compound observed values share the same static attribution context except for the identification of elements. An example is the blood pressure application, where the nomenclature base term expresses “Blood Pressure” and more specific terms express “Blood Pressure Systolic,” “Blood Pressure Diastolic,” and “Blood Pressure Mean.” The corresponding DIM would contain only a single instance of a numeric object, which would use one of the compound numeric observed value formats to represent the “systolic,” “diastolic,” and “mean” parts of the “Blood Pressure.”

6.3.4.4 Numeric object methods

None

6.3.4.5 Numeric object events

None

6.3.4.6 Other numeric services

None

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6.3.5 RT-SA class

6.3.5.1 General

An instance of the RT-SA class represents a wave form measurement. The values of the RT-SA object are sent from the agent to the manager using the EVENT REPORT service (see 7.3). This class is derived from the metric base class.

6.3.5.2 RT-SA class identification

The nomenclature code to identify the RT-SA class is MDC_MOC_VMO_METRIC_SA_RT.

6.3.5.3 RT-SA class attributes

Table 7 defines the set of RT-SA attributes that are supported for personal health device communication.

Table 7—RT-SA attributes

Attribute name	Attribute ID	Attribute type	Remark	Qual.
Sample-Period	MDC_ATTR_TIME_PD_ SAMP	RelativeTime	This attributes defines time interval between successive samples given in 1/8 of a millisecond. Thus, 8000 = 1 s. This attribute shall remain unchanged after the configuration is agreed upon.	M
Simple-Sa-Observed-Value	MDC_ATTR_SIMP_SA_OBS_ VAL	OCTET STRING	This byte array contains the samples that are reported by the agent in the format that is described by the Sa-Specification and Scale-and-Range-Specification. The length shall be even with padding bytes at the end. Sa-Specification defines the actual number of utilized bytes.	M
Scale-and-Range-Specification	MDC_ATTR_SCALE_SPECN_ I8 MDC_ATTR_SCALE_SPECN_ I16 MDC_ATTR_SCALE_SPECN_ I32	ScaleRangeSpec8 ScaleRangeSpec16 ScaleRangeSpec32	This attribute defines mapping between samples and actual values as well as measurement range. The type depends on sample resolution (sample-size field within sample-type field of Sa-Specification). Exactly one of the three specifications shall be included. This attribute shall remain unchanged after the configuration is agreed upon.	M
Sa-Specification	MDC_ATTR_SA_SPECN	SaSpec	This attribute describes the sample array and sample types. This attribute shall remain unchanged after the configuration is agreed upon.	M

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Characteristics of the RT-SA object can be gained by examination of the Sa-Specification attribute. This attribute defines the number of elements in the array and the size of an element and is more thoroughly described in A.3.4.

For agents that support manager-initiated measurement data transmission, refer to 8.9.3.3.3 for information on controlling the activation and/or period of the data transmission. For agents that do not support manager-initiated measurement data transmission, refer to 8.9.3.3.2 for information on the limited control a manager can assert.

— **Scale-and-Range-Specification:**
The Scale-and-Range-Specification attribute defines the coefficients for an algorithm to map the scaled values into their absolute values. The manager shall apply the following algorithm:

$$Y = M \times X + B$$

where

Y = the converted absolute value
M = (upper-absolute-value – lower-absolute-value) / (upper-scaled-value – lower-scaled-value)
B = upper-absolute-value – (M × upper-scaled-value)
X = the scaled value

An example of this algorithm in use can be found in Annex B.

Note that the term *absolute-value* does not refer to the mathematical absolute value in which all values are positive, but rather to the actual, measured value.

6.3.5.4 RT-SA object methods

None

6.3.5.5 RT-SA object events

None

6.3.5.6 Other RT-SA services

None

6.3.6 Enumeration class

6.3.6.1 General

An instance of the enumeration class represents status information and/or annotation information. The values of the enumeration object are coded in the form of normative codes (as defined in ISO/IEEE 11073-10101 [B12]) or in the form of free text. The values of the enumeration object are sent from the agent to the manager using the EVENT REPORT service (see 7.3). This class is derived from the metric base class.

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6.3.6.2 Enumeration class identification

The nomenclature code to identify the enumeration class is MDC_MOC_VMO_METRIC_ENUM.

6.3.6.3 Enumeration class attributes

Table 8 defines the set of enumeration attributes that are supported for personal health device communication.

Table 8—Enumeration attributes

Attribute name	Attribute ID	Attribute type	Remark	Qual.
Enum-Observed-Value-Simple-OID	MDC_ATTR_ENUM_OBS_VAL_SIMP_OID	OID-Type	The value is reported as a nomenclature code. If the Enum-Observed-Value-Partition attribute is valued, it defines the nomenclature partition for this attribute. Otherwise, the OID-Type is taken from the same nomenclature partition as defined in the partition field of the Type attribute. One of Enum-Observed-Value-Simple-OID, Enum-Observed-Value-Simple-Bit-Str , Enum-Observed-Value-Basic-Bit-Str, Enum-Observed-Value-Simple-Str, or Enum-Observed-Value shall be present.	C
Enum-Observed-Value-Simple-Bit-Str	MDC_ATTR_ENUM_OBS_VAL_SIMP_BIT_STR	BITS-32	The value is reported as a bit string of 32-bits. One of Enum-Observed-Value-Simple-OID, Enum-Observed-Value-Simple-Bit-Str , Enum-Observed-Value-Basic-Bit-Str, Enum-Observed-Value-Simple-Str, or Enum-Observed-Value shall be present.	C
Enum-Observed-Value-Basic-Bit-Str	MDC_ATTR_ENUM_OBS_VAL_BASIC_BIT_STR	BITS-16	The value is reported as a bit string of 16-bits. One of Enum-Observed-Value-Simple-OID, Enum-Observed-Value-Simple-Bit-Str, Enum-Observed-Value-Basic-Bit-Str, Enum-Observed-Value-Simple-Str, or Enum-Observed-Value shall be present.	C

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Table 8—Enumeration attributes

Attribute name	Attribute ID	Attribute type	Remark	Qual.
Enum-Observed-Value-Simple-Str	MDC_ATTR_ENUM_OBS_VAL_SIMP_STR	EnumPrintableString	The value is reported as an ASCII printable string. One of Enum-Observed-Value-Simple-OID, Enum-Observed-Value-Simple-Bit-Str , Enum-Observed-Value-Basic-Bit-Str, Enum-Observed-Value-Simple-Str, or Enum-Observed-Value shall be present.	C
Enum-Observed-Value	MDC_ATTR_VAL_ENUM_OBS	EnumObsValue	This attribute defines a structured observed value that permits additional flexibility about the data type of the reported value. One of Enum-Observed-Value-Simple-OID, Enum-Observed-Value-Simple-Bit-Str , Enum-Observed-Value-Basic-Bit-Str, Enum-Observed-Value-Simple-Str, or Enum-Observed-Value shall be present.	C
Enum-Observed-Value-Partition	MDC_ATTR_ENUM_OBS_VAL_PART	NomPartition	This attribute may be used to define the partition from which the Enum-Observed-Value-Simple-OID or the Enum-Observed-Value's observation OID nomenclature term was taken. If not present, the partition is the same as the nomenclature partition defined in the partition field of the Type attribute.	O

6.3.6.4 Enumeration object methods

None

6.3.6.5 Enumeration object events

None

6.3.6.6 Other enumeration services

None

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6.3.7 PM-store class

6.3.7.1 General

An instance of the PM-store class provides long-term storage capabilities for metric data. Data are stored in a variable number of PM-segment objects (see 6.3.8). The stored data of the PM-store object are requested from the agent by the manager using object access services (see 7.3). Anybody not familiar with the PM-store concept may wish to read Annex C for a conceptual overview prior to reading the following subclauses.

6.3.7.2 PM-store class identification

The nomenclature code to identify the PM-store class is MDC_MOC_VMO_PMSTORE.

6.3.7.3 PM-store class attributes

Table 9 defines the set of PM-store attributes that are supported for personal health device communication:

Table 9—PM-store attributes

Attribute name	Attribute ID	Attribute type	Remark	Qual.
Handle	MDC_ATTR_ID_HANDLE	HANDLE	The Handle attribute represents a reference ID for this object. Each object shall have a unique ID assigned by the agent. The handle identifies the object in event reports sent to the manager and to address the object instance in messages invoking object methods. This attribute shall remain unchanged after the configuration is agreed upon.	M
PM-Store-Capab	MDC_ATTR_PM_STORE_ CAPAB	PmStoreCapab	This attribute defines basic capabilities of the PM-store object instance. This attribute shall remain unchanged after the configuration is agreed upon.	M
Store-Sample-Algorithm	MDC_ATTR_METRIC_ STORE_SAMPLE_ALG	StoSampleAlg	This attribute describes how the sample values stored in the PM-segment have been processed. The StoSampleAlg structure describes the available sampling algorithms. If there is no specific sampling algorithm used (in other words the sample values are raw data), then this attribute shall have a value of st-alg-no-downsampling. This attribute shall remain unchanged after the configuration is agreed upon.	M

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Table 9—PM-store attributes

Attribute name	Attribute ID	Attribute type	Remark	Qual.
Store-Capacity-Count	MDC_ATTR_METRIC_STORE_CAPAC_CNT	INT-U32	This attribute is the maximum number of stored PM-segment entries (entries in all contained PM-segments). This attribute shall remain unchanged after the configuration is agreed upon.	O
Store-Usage-Count	MDC_ATTR_METRIC_STORE_USAGE_CNT	INT-U32	This attribute is the actual number of currently stored PM-segment entries (entries in all contained PM-segments).	O
Operational-State	MDC_ATTR_OP_STAT	OperationalState	The attribute indicates if new entries are currently being inserted in any of the contained PM-segments. If any PM-segment contained by this PM-store is having data actively added to it, this attribute shall be set to enabled. Otherwise, it shall be set to disabled.	M
PM-Store-Label	MDC_ATTR_PM_STORE_LABEL_STRING	OCTET STRING	This attribute is an application-dependent label for the PM-store in printable ASCII to indicate its intended use and may be used for display purposes. This attribute shall remain unchanged after the configuration is agreed upon.	O
Sample-Period	MDC_ATTR_TIME_PD_SAMP	RelativeTime	This attribute determines the frequency at which entries are added to the PM-segments. This attribute shall be present either in the PM-store (in which case it applies to all periodically storing PM-segments in the PM-store) or alternatively in each PM-segment, if values are sampled periodically, so the time difference for two entries in the Fixed-Segment-Data is constant (i.e., the pmsc-peri-seg-entries bit in the Pm-Store-Capab attribute is set). This attribute shall remain unchanged after the configuration is agreed upon.	C
Number-Of-Segments	MDC_ATTR_NUM_SEG	INT-U16	This attribute is the number of currently instantiated PM-segments contained in the PM-store. Note that the PM-segment attribute Instance-Number is NOT related to this number (i.e., does not need to be in the range from 0 to Number-Of-Segments), but shall be retrieved with the Get-Segment-Info method.	M

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Table 9—PM-store attributes

Attribute name	Attribute ID	Attribute type	Remark	Qual.
Clear-Timeout	MDC_ATTR_CLEAR_ TIMEOUT	RelativeTime	This timeout attribute defines the minimum time that the manager shall wait for the completion of a PM-store clear command. If, after the manager sends a Confirmed Action(Clear Segments) invoke command, the timeout expires before the manager receives the corresponding Confirmed Action response message, the manager shall transition to the Unassociated state as described in 8.9.5.6.	M

The attributes Handle and PM-Store-Capab are part of the agent configuration; therefore, the manager knows the corresponding attribute values after the Configuring procedure.

6.3.7.4 PM-store object methods

Table 10 defines the methods (actions) of a PM-store object. These methods can be invoked using the ACTION service.

Table 10—PM-store object methods

Method/Action	Mode	Action-type	action-info-args	Resulting action-info-args
Clear-Segments	Confirmed	MDC_ACT_SEG_CLR	SegmSelection	(empty)
Get-Segment-Info	Confirmed	MDC_ACT_SEG_GET_ INFO	SegmSelection	SegmentInfoList
Trig-Segment-Data-Xfer	Confirmed	MDC_ACT_SEG_ TRIG_XFER	TrigSegmDataXfer-Req	TrigSegmDataXferRsp

If an agent supports the PM-store class, the support of the Get-Segment-Info and Trig-Segment-Data-Xfer methods is mandatory. Support for the Clear-Segments method is optional and is indicated in the PM-Store-Capab attribute.

— **Clear-Segments:**
This method allows the manager to delete the data currently stored in one or more selected PM-segments. All entries in the selected PM-segments are deleted. If the agent supports a variable number of PM-segments, the agent may delete empty PM-segments. Additionally, the agent may clear PM-segments without direction from the manager (e.g., the user of the agent could choose to delete data stored on the agent); however, if doing so while in an Associated state, the Instance-Number shall remain empty for the duration of the association. The Instance-Number of all other PM-segments shall be unaffected by clearing a segment. If this method is invoked on a PM-segment that has the Operational-State attribute set to enabled, the agent shall reply with a not-allowed-by-object error (roer) with a return code of MDC_RET_CODE_OBJ_BUSY.

Note that the behavior of the Clear-Segments method is application specific. The method may remove

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all entries from the specified PM-segment, leaving it empty, or it may remove the defined PM-segment completely. This behavior is defined in the PM-Store-Capab attribute. For specific applications, recommendations are defined in corresponding device specializations, making use of the PM-store.

— **Get-Segment-Info:**
This method allows the manager to retrieve PM-segment attributes of one or more PM-segments, with the exception of the Fixed-Segment-Data attribute which contains the actual stored data and is retrieved by using the Trig-Segment-Data-Xfer method. In particular, the Get-Segment-Info method allows the manager to retrieve the Instance-Number attributes of the PM-segment object instances and their data contents.

— **Trig-Segment-Data-Xfer:**
This method allows the manager to start the transfer of the Fixed-Segment-Data attribute of a specified PM-segment. The agent indicates in the response if it accepts or denies this request. If the agent accepts the request, the agent sends Segment-Data-Event messages as described in 6.3.7.5. If this method is invoked on a PM-segment that has the Operational-State attribute set to enabled, the agent shall reply with a not-allowed-by-object error (roer) with a return code of MDC_RET_CODE_OBJ_BUSY.

6.3.7.5 PM-store object events

Table 11 defines the potential events sent by a PM-store object:

Table 11 —PM-store object events

Event	Mode	Event-type	Event-info parameter	Event-reply-info
Segment-Data-Event	Confirmed	MDC_NOTI_ SEGMENT_DATA	SegmentDataEvent	SegmentDataResult

— **Segment-Data-Event:**
This event sends data stored in the Fixed-Segment-Data of a PM-segment from the agent to the manager. The event is triggered by the manager by the Trig-Segment-Data-Xfer method. Once the data transfer is triggered, the agent sends Segment-Data-Event messages until the complete Fixed-Segment-Data is transferred or the transfer is aborted by the manager or agent. See Transfer PM-segment content in 8.9.3.4.2 for a full description.

It is encouraged to place as many segment entries contained in a Segment-Data-Event as possible to reduce the number of messages required for the transfer of the segment.

Support for the event by the agent is mandatory if the agent supports PM-store objects.

6.3.7.6 Other PM-store services

6.3.7.6.1 GET service

Support for the GET service shall be provided by any agent that supports one or more PM-store objects only while in the Operating state. The manager uses the GET service to retrieve the values of all PM-store object attributes.

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The manager may request the PM-store object attributes of the agent in which case the manager shall send the "Remote Operation Invoke | Get" command (see roiv-cmip-get in A.10.2) with the handle value of the PM-store object, as defined in the agent's configuration. The agent shall respond by reporting its PM-store object attributes to the manager using the "Remote Operation Response | Get" response (see rors-cmip-get in A.10.2).

6.3.8 PM-segment class

6.3.8.1 General

An instance of the PM-segment class represents a persistently stored episode of measurement data. A PM-segment object is not part of the static agent configuration because the number of instantiated PM-segment instances may dynamically change. The manager accesses PM-segment objects indirectly by methods and events of the PM-store object.

6.3.8.2 PM-segment class identification

The nomenclature code to identify the PM-segment class is MDC_MOC_PM_SEGMENT.

6.3.8.3 PM-segment class attributes

Table 12 defines the set of PM-segment attributes that are supported for personal health device communication.

Table 12 —PM-segment attributes

Attribute name	Attribute ID	Attribute type	Remark	Qual.
Instance-Number	MDC_ATTR_ID_INSTNO	InstNumber	The Instance-Number is the ID of a specific PM-segment object instance. It is used by the manager to address a PM-segment.	M
PM-Segment-Entry-Map	MDC_ATTR_PM_SEG_MAP	PmSegmentEntryMap	This attribute defines the format and contents of one stored entry. An entry has an optional header containing information applicable to all elements in the entry. The entry then contains one or more elements, defined by the class, metric ID, handle, and an attribute value map defining the object attributes for each element in the PM-segment.	M

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Table 12 —PM-segment attributes

Attribute name	Attribute ID	Attribute type	Remark	Qual.
PM-Seg-Person-Id	MDC_ATTR_PM_SEG_ PERSON_ID	PersonId	This standard supports devices that have simple support for data from multiple persons. A person ID is used to differentiate different persons. If the PM-store is able to store data for multiple persons, it shall set the pmsc-multi-person bit in the PM-Store-Capab attribute. If this bit is set, all PM-segment instances contained in the PM-store shall support the PM-Seg-Person-Id attribute. Otherwise, this attribute is not defined.	C
Operational-State	MDC_ATTR_OP_STAT	OperationalState	This attribute indicates if new entries are currently being inserted into this PM-segment. If this PM-segment is having data actively added to it, this attribute shall be set to enabled. Otherwise, it shall be set to disabled.	M
Sample-Period	MDC_ATTR_TIME_PD_ SAMP	RelativeTime	This attribute defines the frequency at which entries are added to the PM-segment. This attribute shall be present either in the PM-store (in which case it applies to all periodically storing PM-segments in the PM-store) or alternatively in each PM-segment. If values are sampled, then the pmsc-peri-seg-entries bit in the PM-Store-Capab attribute shall be set.	C
Segment-Label	MDC_ATTR_PM_SEG_ LABEL_STRING	OCTET STRING	This attribute is an application-dependent label in printable ASCII for the segment to indicate its intended use and may be used for display purposes.	O
Segment-Start-Abs-Time	MDC_ATTR_TIME_START_ SEG	AbsoluteTime	This attribute defines the start time of segment.	O
Segment-End-Abs-Time	MDC_ATTR_TIME_END_ SEG	AbsoluteTime	This attribute defines the end time of segment.	O
Date-and-Time-Adjustment	MDC_ATTR_TIME_ABS_ ADJUST	AbsoluteTimeAdjust	This attribute reports any date and time adjustments that occur either due to a person's changing the clock or events such as daylight savings time. If the agent ever adjusts the date and time, this attribute is reports such adjustment.	C

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Table 12 —PM-segment attributes

Attribute name	Attribute ID	Attribute type	Remark	Qual.
Segment-Usage-Count	MDC_ATTR_SEG_USAGE_CNT	INT-U32	This attribute gives the actual (current) number of stored entries.	O
Segment-Statistics	MDC_ATTR_SEG_STATS	SegmentStatistics	This attribute defines the array for reporting minimum, mean, maximum statistics for each element to be tagged.	O
Fixed-Segment-Data	MDC_ATTR_SEG_FIXED_DATA	N/A The data is stored internal to the device and so this data type never occurs in any protocol definition directly.	This attribute defines the segment data transferred as an array of entries in a format as specified in the PM-Segment-Entry-Map attribute. This is defined here as an opaque data structure without a defined data type. Note that this attribute is not directly accessible; it is only retrievable by the manager using the PM-store Trig-Segm-Data-Xfer method.	M
Confirm-Timeout	MDC_ATTR_CONFIRM_TIMEOUT	RelativeTime	This informational timeout attribute defines the minimum time that the agent shall wait for a Response message from the manager after issuing a Confirmed Event Report invoke message before timing out and transitioning to the Unassociated state. This is an informational attribute for the benefit of the manager. If this attribute is supplied, it shall match the actual timeout value that the agent uses for the Confirmed Event Report generated from the PM-store object. This attribute is informational for the manager in the sense that the manager does not use this attribute in an actual implementation of the protocol (i.e., the manager does not time out on an agent-generated Confirmed Event Report). However, the manager might wish to use this information to prioritize its handling of a “short” timeout agent over that of a “long” timeout agent.	O

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Table 12 —PM-segment attributes

Attribute name	Attribute ID	Attribute type	Remark	Qual.
Transfer-Timeout	MDC_ATTR_TRANSFER_ TIMEOUT	RelativeTime	This timeout attribute defines the minimum time that the manager shall wait for the complete transfer of PM-segment information. If the timeout expires prior to the reception of the complete PM-segment, the manager shall transition to the Unassociated state as described in 8.9.5.6.	M

The Fixed-Segment-Data attribute stores an array of identically formatted entries. In cases where a measurement is not available at the required time, then the value for a numeric measurement represented by the (S)FLOAT-type data type shall use the special NaN (not a number) value to indicate an unavailable value.

The Fixed-Segment-Data attribute may hold very large amounts of data, depending on the agent capabilities and the application. An agent may choose to restrict the maximum size of the Fixed-Segment-Data attribute in a way that is aligned with the maximum transmission unit of the transport system. In order to support this type of behavior, a manager shall be able to support the transfer of Fixed-Segment-Data attributes in multiple application messages.

6.3.8.4 PM-segment object methods

None

6.3.8.5 PM-segment object events

None

6.3.8.6 Other PM-segment services

None

6.3.9 Scanner classes

6.3.9.1 General

A scanner object is an observer and “summarizer” of object attribute values. It observes attributes of metric objects (e.g., numeric objects) and generates summaries in the form of notification event reports. See Figure 5 for the class hierarchy of the scanner classes. Each class is described in 6.3.9.2 through 6.3.9.5, respectively.

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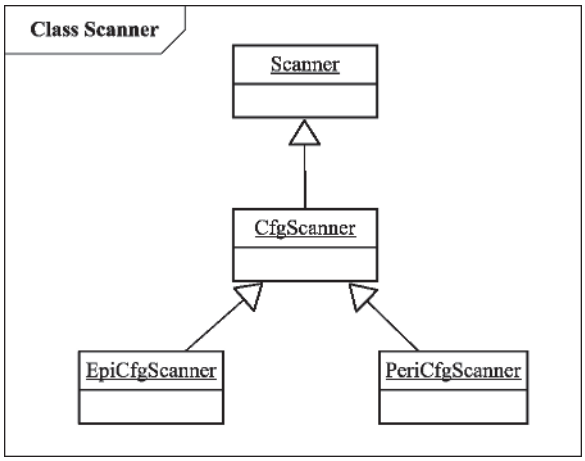

Figure 5 —Personal health device – DIM – scanner model

The different scanner classes (periodic and episodic) as well as the different instances should be used to distribute different data types across one or many data flows represented by a scanner instance. A pulse oximetry application might choose to have a periodic configurable scanner for RT-SA objects with a Reporting-Interval of 50 ms, a periodic configurable scanner with a Reporting-Interval of 1 s for numeric and enumeration objects, and an episodic configurable scanner for beat-to-beat metric objects (numeric or enumeration objects).

6.3.9.2 Scanner class

6.3.9.2.1 General

The scanner class is an abstract class defining attributes, methods, events, and services that are common for its subclasses. As such, it cannot be instantiated.

The scanner concept provides three different event report notifications: variable format, fixed format, and grouped format. See 7.4.5 for the reporting of observed object attributes. The event report formats are described further in 6.3.9.4.5, 6.3.9.5.5, and A.11.5, respectively.

More specialized scanner classes are derived from the scanner base class.

6.3.9.2.2 Scanner class identification

The nomenclature code to identify the scanner class is MDC_MOC_SCAN.

6.3.9.2.3 Scanner class attributes

Table 13 defines the set of scanner attributes that are supported for personal health device communication.

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Table 13 —Scanner attributes

Attribute name	Attribute ID	Attribute type	Remark	Qual.
Handle	MDC_ATTR_ID_HANDLE	HANDLE	Scanners are identified by handles. This attribute shall remain unchanged after the configuration is agreed upon.	M
Operational-State	MDC_ATTR_OP_STAT	OperationalState	This attribute defines if scanner is active and can be set by the manager.	M
Scan-Handle-List	MDC_ATTR_SCAN_ HANDLE_LIST	HANDLEList	This attribute defines the metric-derived objects that might be reported in the Unbuf-Scan-Report-Var, Buf-Scan-Report-Var, Unbuf-Scan-Report-Fixed, Buf-Scan-Report-Fixed, or any of the four multiple-person equivalents. For episodic scanners, a particular object is included in an event report whenever there are changes in one or more attribute values. For periodic scanners, the scanned objects and attribute values are reported in each period. The manager shall not assume the order of the objects contained in the event reports is the same as the order of the Scan-Handle-List. This attribute shall be present if any of these eight reporting styles are used by the scanner.	C
Scan-Handle-Attr-Val-Map	MDC_ATTR_SCAN_ HANDLE_ATTR_VAL_MAP	HandleAttrValMap	This attribute defines the metric-derived objects, the attributes, and the order in which objects and attribute values are reported in a Unbuf-Scan-Report-Grouped, Buf-Scan-Report-Grouped, Unbuf-Scan-Report-MP-Grouped, or Buf-Scan-Report-MP-Grouped. All values shall be present to maintain a consistent layout of message. This attribute shall be present if any of these four reporting styles are used.	C

6.3.9.2.4 Scanner object methods

None

6.3.9.2.5 Scanner object events

See the derived class event descriptions in 6.3.9.4.5 and 6.3.9.5.5.

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6.3.9.2.6 Other scanner services

— **SET service:**
Agents that have scanner derived objects shall support the SET service for the Operational-State attribute of the scanner objects.

6.3.9.3 CfgScanner class

6.3.9.3.1 General

The CfgScanner class is an abstract class defining attributes, methods, events, and services that are common for its subclasses. In particular, it defines the communication behavior of a configurable scanner object. As such, it cannot be instantiated.

6.3.9.3.2 Configurable scanner class identification

The nomenclature code to identify the configurable scanner class is MDC_MOC_SCAN_CFG.

6.3.9.3.3 Configurable scanner class attributes

Table 14 defines the set of scanner attributes that are supported for personal health device communication.

Table 14—Configurable scanner attributes

Attribute name	Attribute ID	Attribute type	Remark	Qual.
Confirm-Mode	MDC_ATTR_CONFIRM_ MODE	ConfirmMode	This attribute defines whether event reports are sent confirmed or unconfirmed.	M
Confirm-Timeout	MDC_ATTR_CONFIRM_ TIMEOUT	RelativeTime	This informational timeout attribute defines the minimum time that the agent shall wait for a Response message from the manager after issuing a Confirmed Event Report invoke message before timing out and transitioning to the Unassociated state. This is an informational attribute for the benefit of the manager. If this attribute is supplied, it shall match the actual timeout value that the agent uses for the Confirmed Event Report generated from the scanner object. This attribute is informational for the manager in the sense that the manager does not use this attribute in an actual	C

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