



Health informatics—Personal health device communication

**Part 10441: Device specialization—
Cardiovascular fitness and activity monitor**

IEEE Engineering in Medicine and Biology Society

Sponsored by the
11073TM Standard Committee

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Health informatics—Personal health device communication

**Part 10441: Device specialization—
Cardiovascular fitness and activity monitor**

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of the

IEEE Engineering in Medicine and Biology Society

Approved 26 September 2008

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Abstract: Within the context of the ISO/IEEE 11073 family of standards for device communication, this standard establishes a normative definition of communication between personal telehealth cardiovascular fitness and activity monitor devices and compute engines (e.g., cell phones, personal computers, personal health appliances, and set top boxes) in a manner that enables plug-and-play interoperability. It leverages appropriate portions of existing standards including ISO/IEEE 11073 terminology, information models, application profile standards, and transport standards. It specifies the use of specific term codes, formats, and behaviors in telehealth environments restricting optionality in base frameworks in favor of interoperability. This standard defines a common core of communication functionality for personal telehealth cardiovascular fitness and activity monitor devices.

Keywords: activity monitor, cardiovascular fitness, medical device communication, personal health devices

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Introduction

This introduction is not part of IEEE Std 11073-10441-2008, Health informatics—Personal health device communication—Part 10441: Device specialization—Cardiovascular fitness and activity monitor.

ISO/IEEE 11073 standards enable communication between medical devices and external computer systems. This document uses the optimized framework created in IEEE Std 11073-20601^a and describes a specific, interoperable communication approach for cardiovascular fitness and activity monitors. 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 devices.

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Health informatics—Personal health device communication

Part 10441: Device specialization— Cardiovascular fitness and activity monitor

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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 establishes a normative definition of the communication between personal cardiovascular fitness and activity-monitoring devices and managers (e.g., cell phones, personal computers, personal health appliances, and set top boxes) in a manner that enables plug-and-play interoperability. It leverages appropriate portions of existing standards, including ISO/IEEE 11073 terminology and information models. It specifies the use of specific term codes, formats, and behaviors in telehealth environments restricting optionality in base frameworks in favor of interoperability. This standard defines a common core of communication functionality for personal telehealth cardiovascular fitness and activity monitor devices. In this context, cardiovascular fitness and activity monitor devices are being used broadly to cover cardiovascular fitness and activity-monitor devices that measure physical actions and the body’s various physiological responses to that activity.

1.2 Purpose

This standard addresses a need for an openly defined, independent standard for controlling information exchange to and from personal health devices and compute engines (e.g., cell phones, personal computers, personal health appliances, and set top boxes). Interoperability is the key to growing the potential market for these devices and to enabling people to be better informed participants in the management of their health.

1.3 Context

See IEEE Std 11073-20601™ for an overview of the environment within which this standard is written.

This document, IEEE Std 11073-10441-2008, defines the device specialization for the cardiovascular fitness and activity monitor, being a specific agent type, and it provides a description of the device concepts, its capabilities, and its implementation according to this standard.

This standard is based on IEEE Std 11073-20601, which in turn draws information from both ISO/IEEE 11073-10201:2004 [B3]¹ and ISO/IEEE 11073-20101:2004 [B4]. The medical device encoding rules (MDER) used within this standard are fully described in IEEE Std 11073-20601.

This standard reproduces relevant portions of the nomenclature found in ISO/IEEE 11073-10101:2004 [B2] and adds new nomenclature codes for the purposes of this standard. Between this standard and ISO/IEEE 11073-20601, all required nomenclature codes for implementation are documented.

NOTE—In this standard, IEEE Std 11073-104zz is used to refer to a single instance of any device specialization standards that utilize IEEE Std 11073-20601, where zz can be any number from 01 to 99, inclusive.²

2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so that each referenced document is cited in text and its relationship to this document 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 11073-20601™-2008, Health informatics—Personal health device communication—Part 20601: Application profile—Optimized Exchange Protocol.^{3,4}

See Annex A for all informative material referenced by this standard.

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 Terms* [B1] 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 class: In object-oriented modeling, a class describes the attributes, methods, and events that objects instantiated from the class utilize.

3.1.3 compute engine: *See: manager.*

3.1.4 device: A term used to refer to a physical apparatus implementing either an agent or a manager role.

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

² Notes in text, tables, and figures are given for information only and do not contain requirements needed to implement the standard.

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⁴ IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, Piscataway, NJ 08854, USA (<http://standards.ieee.org/>).

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. Some examples of managers include a cellular phone, health appliance, set top box, or a computer system.

3.1.7 obj-handle: *See: handle.*

3.1.8 object: In object-oriented modeling, a particular instantiation of a class. The instantiation realizes attributes, methods, and events from the class.

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

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

3.2 Acronyms and abbreviations

APDU	application protocol data unit
ASN.1	Abstract Syntax Notation One
DIM	domain information model
EUI-64	extended unique identifier (64 bits)
ICS	implementation conformance statement
MDC	medical device communication
MDER	medical device encoding rules
MDS	medical device system
MOC	managed object class
PDU	protocol data unit
PHD	personal health device
RPM	revolutions per minute
RT-SA	real-time sample array
VMO	virtual medical object
VMS	virtual medical system

4. Introduction to ISO/IEEE 11073 personal health devices

4.1 General

This standard and the remainder of the series of ISO/IEEE 11073 Personal Health Device standards fit in the larger context of the ISO/IEEE 11073 series of standards. The full suite of standards enables agents to interconnect and interoperate with managers and with computerized health-care information systems. See IEEE Std 11073-20601 for a description of the guiding principles for this series of ISO/IEEE 11073 Personal Health Device standards.

IEEE Std 11073-20601 supports the modeling and implementation of an extensive set of personal health devices (PHDs). This standard defines aspects of the cardiovascular fitness and activity monitor device. It describes all aspects necessary to implement the application layer services and data exchange protocol between an ISO/IEEE 11073 PHD cardiovascular fitness and activity monitor agent and a manager. This standard defines a subset of the objects and functionality contained in IEEE Std 11073-20601 extends and adds definitions where appropriate. All new definitions are given in Annex B in Abstract Syntax Notation One (ASN.1). Nomenclature codes referenced in this standard, which are not defined in IEEE Std 11073-20601, are normatively defined in Annex C.

4.2 Introduction to IEEE 11073-20601 modeling constructs

4.2.1 General

The ISO/IEEE 11073 series of standards, and in particular IEEE Std 11073-20601, is based on an object-oriented systems management paradigm. The overall system model is divided into three principal components: the domain information model (DIM), the service model, and the communication model. See IEEE Std 11073-20601 for a detailed description of the modeling constructs.

4.2.2 Domain information model

The DIM is a hierarchical model that describes an agent as a set of objects. These objects and their attributes represent the elements that control behavior and report on the status of the agent and data that the agent can communicate to a manager. Communication between the agent and the manager is defined by the application protocol in IEEE Std 11073-20601.

4.2.3 Service model

The service model defines the conceptual mechanisms for the data exchange services. Such services are mapped to messages that are exchanged between the agent and the manager. Protocol messages within the ISO/IEEE 11073 series of standards are defined in ASN.1. The messages defined in IEEE Std 11073-20601 can coexist with messages defined in other standard application profiles defined in the ISO/IEEE 11073 series of standards.

4.2.4 Communication model

In general, the communication model supports the topology of one or more agents communicating over logical point-to-point connections to a single manager. For each logical point-to-point connection, the dynamic system behavior is defined by a connection state machine as specified in IEEE Std 11073-20601.

4.2.5 Implementing the models

An agent implementing this standard shall implement all mandatory elements of the information, service, and communication models as well as all conditional elements where the condition is met. The agent should implement the recommended elements, and it may implement any combination of the optional elements. A manager implementing this standard shall utilize at least one of the mandatory, conditional, recommended, or optional elements. In this context, “utilize” means to use the element as part of the primary function of the manager device. For example, a manager whose primary function is to display data would need to display a piece of data in the element in order to utilize it.

5. Cardiovascular fitness and activity monitor device concepts and modalities

Cardiovascular fitness and activity monitor agents measure the physical activity of an individual and record the physiological response to that activity. Agents include treadmills, exercise bikes, heart rate monitors, bike computers, pedometers, and overall activity/lifestyle monitors. Although there is great variety in the forms of these agents, there is significant commonality and overlap in the measurements they make.

5.1 General concepts

Agents in this category operate in a store and forward mode, where activity is measured for a period of time and sometime after the measurement period has ended; it makes the measurements available to the manager. This measurement period is called a session.

The data associated with a session may vary greatly from agent to agent. Minimally, the session will include information about the date and time of the session, as well as the session duration and the activity that was measured during the session. In addition, there may be a variety of metrics that are calculated for the entire session, like total distance or mean speed.

In some agents, the concept of subsessions is important. These subsessions provide a mechanism to break up a session into smaller components that represent specific periods within the session. The primary example of this is the lap concept, where an agent may allow the user to mark when they have completed a lap in order to be more granular in their data organization. Like a session, subsessions may have a variety of metrics that apply across the entire subsession (i.e., subsession distance and mean speed).

5.2 Session

A session defines the envelope that contains all of the measurements associated with an episode of activity/exercise. Each session defines its start date and time of the episode as well as the duration and the activity that the user engaged in during the episode.

5.3 Subsession

The subsession defines the envelope that contains all of the measurements associated with a portion of the session. Each subsession defines its start date, start time, and duration; it also contains the activity that the user engaged in during the subsession.

5.4 Heart rate

The rate at which the heart beats is a key indicator of physical exertion. Heart rates can be calculated as maximum, minimum, and mean values for a session or subsession. Additionally, a user maximum heart rate may be captured for a session or subsession. The maximum user heart rate is typically manually entered by the user and can be useful in providing context for the other values so that the maximum, minimum, and mean heart rates achieved during an exercise session can be compared with the user's absolute maximum heart rate.

5.5 Breathing rate

The breathing rate can provide information on lung function in response to physical exertion. The breathing rate can be calculated as maximum, minimum, and mean values for a session or subsession.

5.6 Distance

Distance defines the total distance covered during each session and/or subsession. Distance may be specified as the actual distance such as meters or feet, or in more abstract concepts such as steps taken or flights of stairs climbed.

Using the distance and elevation profile shown in Figure 1, if a person were to travel $a \rightarrow b \rightarrow c$, the distance traveled would be $ab + bc$.

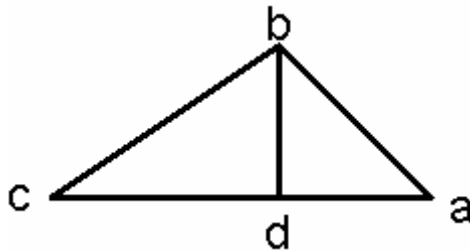


Figure 1—Distance and elevation profile

5.7 Ascent and descent time and distance

Ascent and descent time record the period spent gaining or losing elevation during a session or subsession and may be used to determine a measure of work expended. Ascent and descent distance record the respective distances covered during those periods.

If, in Figure 1, a person traveled $a \rightarrow b \rightarrow c$, the ascent distance would be ab and the descent distance would be bc .

5.8 Speed

Speed adds additional context to the work being done and is used to capture how fast the user moved across a distance (5.6) in a session or subsession. Minimum, mean, and maximum speeds can be recorded for sessions or subsessions.

5.9 Altitude gain and loss

While ascent and descent time and distance (5.7) capture the distance and time spent either gaining or losing altitude, the measurement of altitude gain and loss depicts the cumulative height gained and cumulative height lost during ascents and descents in a session or subsession.

If in Figure 1, a person traveled $a \rightarrow b \rightarrow c$, then both the altitude gain and the altitude loss would be bd . These values are equal because the start and finish for the route of travel are on the same elevation. However, if a person traveled from $a \rightarrow b$, the altitude gain would be bd , and the altitude loss would be zero (0).

5.10 Altitude

Altitude represents a point of elevation, relative to sea level, as measured at the beginning of a session or subsession.

5.11 Cadence

Cadence records the frequency of a repetitive action, such as the rate of revolution of the pedals of a bicycle or striding frequency of a runner or walker. Cadence is recorded as a minimum, mean, and maximum for a session or subsession.

5.12 Power

Power is a measure of the work rate of a user. Power is measured as a minimum, mean, and maximum value over a session or subsession.

5.13 Stride length

This is a measurement of the distance covered in a single stride/step when walking or running. It is captured as minimum, mean, and maximum over a session or subsession.

5.14 Energy expended

This is the amount of energy expended during a session or subsession.

5.15 Calories ingested

This is the number of calories consumed or ingested by a person during a session or subsession.

5.16 Carbohydrate calories ingested

This is the number of carbohydrate calories consumed or ingested by a person during a session or subsession.

5.17 Incline

This measurement represents the steepness of the incline being traveled as a minimum, mean, or maximum over a session or subsession. Minimum incline is equivalent to maximum decline.

5.18 Resistance

This measurement represents the minimum, mean, or maximum resistance employed over a session or subsession. This measurement applies primarily to machines that apply variable resistance to a person doing an exercise.

5.19 Program identifier

This measurement identifies the exercise program used by the person during a session or subsession.

5.20 Activity time

This concept differs from a session or subsession in that this concept provides categorization and aggregation of the time spent in certain activities within the associated session or subsession. Typically, this concept is employed in general daily activity monitoring where daily activities are categorized by how much time in the session or subsession was spent in various activities such as sleeping, sitting, or walking.

5.21 Sustained physical activity threshold

This measurement represents the amount of time a person must be engaged in physical activity to be considered sustained physical activity, which is an important metric in determining a person's activity level.

5.22 Slopes

This is the number of slopes skied by a person.

5.23 Latitude and longitude

This is the latitudinal (north/south) and longitudinal (east/west) location of the person at a point in time.

5.24 Intensity of activity

This measurement reports the intensity of a certain activity. It is expected to be used as a supplement to the program identifier to describe the nature of the activity (e.g., slow running, moderate running, or fast running).

5.25 Weight

Some of the observations made by an agent depend on the weight of the person using it. This observation is typically entered manually by the user although an agent may have the capability to measure this directly.

5.26 Height

Some of the observations made by an agent depend on the height of the person using it. This observation is typically entered manually by the user.

5.27 Age

Some of the observations made by an agent depend on the age of the person using it. This observation is typically entered manually by the user.

6. Cardiovascular fitness and activity monitor domain information model

6.1 Overview

This clause describes the domain information model of the cardiovascular fitness and activity monitor.

6.2 Class extensions

In this standard, no class extensions are defined with respect to IEEE Std 11073-20601.

6.3 Object instance diagram

The object instance diagram of the cardiovascular fitness and activity monitor domain information model, defined for the purposes of this standard, is shown in Figure 2.

The objects of the DIM, as shown in Figure 2, are described in 6.4 to 6.12. This includes the medical device system (MDS) object (see 6.4), the numeric objects (see 6.6), the real-time sample array (RT-SA) objects (see 6.7), the enumeration objects (see 6.8), the PM-store objects (see 6.9), and the scanner objects (see 6.10). See 6.11 for rules for extending the information model beyond elements as described in this standard. Each clause that describes an object of the cardiovascular fitness and activity monitor contains the following information:

- The nomenclature code used to identify the class of the object. One example where this code is used is the configuration event, where the object class is reported for each object. This allows the manager to determine whether the class of the object being specified is a numeric, real-time sample array class, enumeration, scanner, or PM-store class.
- The attributes of the object. Each object has attributes that represent and convey information on the physical agent and its data sources. Each object has a handle attribute that identifies the object instance within an agent. Attribute values are accessed and modified using communication services such as GET and SET. Attributes types are defined using ASN.1. The ASN.1 definitions for new attribute types specific to this standard are in Annex B, and the ASN.1 definitions for existing attribute types referenced in this standard are in IEEE Std 11073-20601.
- The methods available on the object.
- The potential events generated by the object. Data are sent to the manager using events.
- The available services such as getting or setting attributes.

The attributes for each class are defined in tables that specify the name of the attribute, its value, and its qualifier. The qualifiers mean M — Attribute is Mandatory, C — Attribute is Conditional and depends on the condition stated in the Remark or Value column (if IEEE Std 11073-20601 is referenced, then it contains the conditions), R — Attribute is Recommended, NR — Attribute is Not Recommended, and O — Attribute is Optional. Mandatory attributes shall be implemented by the agent. Conditional attributes shall be implemented if the condition applies and may be implemented otherwise. Recommended attributes should be implemented by the agent. Not recommended attributes should not be implemented by the agent. Optional attributes may be implemented on the agent.

The attributes can be either static, meaning that they shall remain unchanged after the configuration is agreed upon, or dynamic, meaning that the attribute may change at some point after configuration.

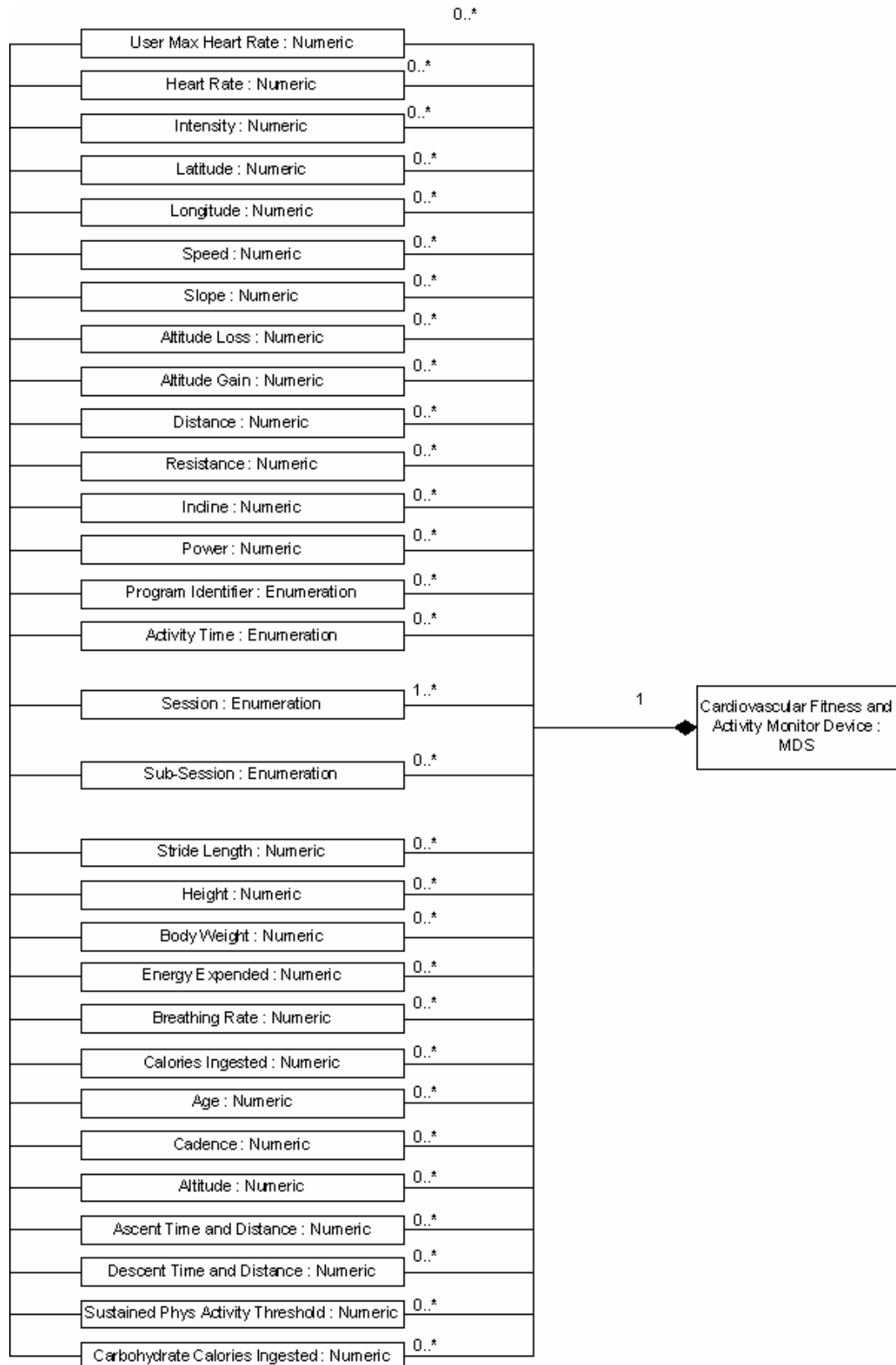


Figure 2—Object instance diagram

6.4 Types of configuration

6.4.1 General

As specified in IEEE Std 11073-20601, there are two styles of configuration available. Subclauses 6.4.2 and 6.4.3 briefly introduce standard and extended configurations.

6.4.2 Standard configuration

This standard does not define any standard configurations since the set of sensors for each agent configuration is likely to vary significantly for each deployment scenario. Therefore, all configurations shall be specified as extended configurations.

6.4.3 Extended configuration

In extended configurations, the agent's configuration is not predefined in a standard. The agent determines which objects, attributes, and values that it wants to use in a configuration and assigns a configuration identifier. When the agent associates with a manager, it negotiates an acceptable configuration. Typically, the manager does not recognize the agent's configuration on the first connection, so the manager responds that the agent must send its configuration information as a configuration event report. If, however, the manager already understands the configuration, either because it was preloaded in some way or the agent had previously associated with the manager, then the manager responds that the configuration is known and no further configuration information needs to be sent.

6.5 Medical device system object

6.5.1 MDS object attributes

Table 1 summarizes the attributes of the cardiovascular fitness and activity monitor MDS object. The nomenclature code to identify the MDS object class is MDC_MOC_VMS_MDS_SIMP.

Table 1—MDS object attributes

Attribute name	Value	Qual.
Handle	0	M
System-Type	Attribute not present. See IEEE Std 11073-20601.	C
System-Model	{“Manufacturer”, “Model”}.	M
System-Id	See IEEE Std 11073-20601.	M
Dev-Configuration-Id	Extended configs: 0x4000-0x7FFF.	M
Attribute-Value-Map	See IEEE Std 11073-20601.	C
Production-Specification	See IEEE Std 11073-20601.	O
Mds-Time-Info	See IEEE Std 11073-20601.	C
Date-and-Time	See IEEE Std 11073-20601.	C
Relative-Time	See IEEE Std 11073-20601.	C
HiRes-Relative-Time	See IEEE Std 11073-20601.	C
Date-and-Time-Adjustment	See IEEE Std 11073-20601.	C
Power-Status	<i>onBattery</i> or <i>onMains</i> .	R
Battery-Level	See IEEE Std 11073-20601.	R
Remaining-Battery-Time	See IEEE Std 11073-20601.	R
Reg-Cert-Data-List	See IEEE Std 11073-20601.	O
System-Type-Spec-List	{MDC_DEV_SPEC_PROFILE_HF_CARDIO, 1}.	M
Confrim-Timeout	See IEEE Std 11073-20601.	O

NOTE—See IEEE Std 11073-20601 for information on whether an attribute is static or dynamic.

In the response to a Get MDS object command, only implemented attributes and their corresponding values are returned.

See IEEE Std 11073-20601 for descriptive explanations of the individual attributes as well as for information on attribute ID and attribute type.

The Dev-Configuration-Id attribute holds a locally unique 16-bit identifier that identifies the device configuration. For a cardiovascular fitness and activity monitor agent, this identifier is chosen in the range of extended-config-start to extended-config-end (see IEEE Std 11073-20601) as shown in Table 1.

The agent sends the Dev-Configuration-Id during the Associating state (see 8.3) to identify its configuration for the duration of the association. If the manager already holds the configuration information relating to the Dev-Configuration-Id, it recognizes the Dev-Configuration-Id. Then, the Configuration state (see 8.4) is skipped, and the agent and manager enter the Operating state. If the manager does not recognize the Dev-Configuration-Id, the agent and manager enter the Configuring state.

If an agent implements multiple IEEE 11073-104zz specializations System-Type-Spec-List is a list of type/version pairs each referencing the respective device specialization and version of that specialization.

6.5.2 MDS object methods

Table 2 defines the methods (actions) of the cardiovascular fitness and activity monitor agent's MDS object. These methods are invoked using the Action service. In Table 2, the Subservice type name 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 IEEE Std 11073-20601) or a confirmed action (i.e., roiv-cmip-confirmed-action); the Subservice type (action-type) column defines the nomenclature code to use in the action-type field of an action request and response (see IEEE Std 11073-20601); the Parameters (action-info-args) column defines the associated ASN.1 data structure (see IEEE Std 11073-20601 and ASN.1 definitions) to use in the action message for the action-info-args field of the request; and the Results (action-info-args) column defines the structure to use in the action-info-args of the response.

Table 2—MDS object methods

Service	Subservice type name	Mode	Subservice type (action-type)	Parameters (action-info-args)	Results (action-info-args)
ACTION	Set-Time	Confirmed	MDC_ACT_SET_TIME	SetTimeInvoke	—

Set-Time

This method allows the manager to set a real-time clock in the agent with the absolute time. The agent indicates whether the Set-Time command is valid using the mds-time-capab-set-clock bit in the Mds-Time-Info attribute (see IEEE Std 11073-20601). Agents with an internal real-time clock (RTC) shall indicate this capability by also setting the mds-time-capab-real-time-clock bit in the Mds-Time-Info attribute.

Agents following only this device specialization and no others shall send event reports using agent-initiated measurement data transmission. Agents following this device specialization as well as others shall send event reports in the appropriate fashion. During the association procedure (see 8.3), DataReqModeCapab shall be set to the appropriate value for the event report style. As a result, the manager shall assume the agent does not support any of the MDS-Data-Request features (see IEEE Std 11073-20601 for additional information). Thus, implementation of the MDS-Data-Request method/action is not required in this standard and is not shown in Table 2.

6.5.3 MDS object events

Table 3 defines the events that can be sent by the cardiovascular fitness and activity monitor MDS object.

Table 3—MDS object events

Service	Subservice type name	Mode	Subservice type (event-type)	Parameters (event-info)	Results (event-reply-info)
EVENT REPORT	MDS-Configuration-Event	Confirmed	MDC_NOTI_CONFIG	ConfigReport	ConfigReportRsp
	MDS-Dynamic-Data-Update-Var	Confirmed	MDC_NOTI_SCAN_REPORT_VAR	ScanReportInfoVar	—
	MDS-Dynamic-Data-Update-Fixed	Confirmed	MDC_NOTI_SCAN_REPORT_FIXED	ScanReportInfoFixed	—
	MDS-Dynamic-Data-Update-MP-Var	Confirmed	MDC_NOTI_SCAN_REPORT_MP_VAR	ScanReportInfoMPVar	—
	MDS-Dynamic-Data-Update-MP-Fixed	Confirmed	MDC_NOTI_SCAN_REPORT_MP_FIXED	ScanReportInfoMPFixed	—

— **MDS-Configuration-Event:**

This event is sent by the agent during the configuring procedure 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 measurement data from agent. These data are reported using a generic attribute list variable format. The event is sent as an unsolicited message by the agent (i.e., an agent-initiated measurement data transmission). See 8.5.3 for more information on unsolicited event reporting.

— **MDS-Dynamic-Data-Update-Fixed:**

This event provides dynamic measurement data from the agent. These data are reported in the fixed format defined by the Attribute-Value-Map attribute of the relevant metric objects. The event is sent as an unsolicited message by the agent (i.e., an agent-initiated measurement data transmission). See 8.5.3 for more information on unsolicited event reporting.

— **MDS-Dynamic-Data-Update-MP-Var:**

This is the same as MDS-Dynamic-Data-Update-Var but allows inclusion of data from multiple people.

— **MDS-Dynamic-Data-Update-MP-Fixed:**

This is the same as MDS-Dynamic-Data-Update-Fixed but allows inclusion of data from multiple people.

NOTE—IEEE Std 11073-20601 requires that managers support all of the MDS object events listed above.

6.5.4 Other MDS services

6.5.4.1 GET service

A cardiovascular fitness and activity monitor agent shall support the GET service, which is provided by the MDS object 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.

The manager may request the MDS object attributes of the agent; in which case, the manager shall send the “Remote Operation Invoke | Get” message (see roiv-cmip-get in IEEE Std 11073-20601) with the reserved MDS handle value of 0. The agent shall report its MDS object attributes to the manager using the “Remote Operation Response | Get” message (see rors-cmip-get in IEEE Std 11073-20601). See Table 4 for a summary of the GET service including some message fields.

Table 4—MDS object GET service

Service	Subservice type name	Mode	Subservice type	Parameters	Results
GET	<na>	<implied confirmed>	<na>	GetArgumentSimple = (obj-handle = 0), attribute-id-list <i><optional></i>	GetResultSimple = (obj-handle = 0), attribute-list

See 8.5.2 for details on the procedure for getting the MDS object attributes.

6.5.4.2 SET service

The cardiovascular fitness and activity monitor specialization does not require an implementation to support the MDS object SET service.

6.6 Numeric objects

6.6.1 General

6.6.1.1 Definitions

The numeric objects listed in this clause represent the numeric observations that can be produced by a cardiovascular fitness and activity monitor agent. The nomenclature code to identify a numeric object class is MDC_MOC_VMO_METRIC_NU. Each object specifies how each of the attributes is to be used, but there are some concepts that apply to each numeric in a general fashion that are described in subclauses 6.6.1.2 through 6.6.1.7.

6.6.1.2 Dependent attributes

Sometimes, the interpretation of one attribute value in an object depends on other attribute values in the same object. For example, Unit-Code and Unit-Label-String provide context for the observed values. Whenever a contextual attribute changes, the agent shall report these changes to the manager using an MDS object event (see 6.5.3) prior to reporting any of the dependent values.

6.6.1.3 Timestamps

The timestamp attributes shall be consistently used in all objects and are not repeated for each numeric object to reduce redundancy. All numeric object instances are associated with either a session or subsession object, defined in 6.8.2 and 6.8.3, respectively. In order to unambiguously identify object association, the numeric object instance shall have a timestamp identical to its associated session or subsession object instance.

The timestamp attribute used for each numeric object instance shall be the same as the one used for the associated session or subsession object instance. For example, if the associated session object instance uses the Absolute-Time-Stamp, this is the attribute the numeric object instance shall use for its timestamp.

6.6.1.4 Source handle reference

It is possible for a session or subsession to have associated numeric objects that represent observations that span the entire session or subsession. Therefore, the Source-Handle-Reference attribute of the numeric object shall identify whether the numeric object instance is associated with either the session or the subsession object. If the numeric object is a session-level observation, the Source-Handle-Reference shall be equal to the value of the handle of the session object. Likewise, if the numeric object represents a subsession-level observation, the Source-Handle-Reference attribute shall be equal to the handle of the subsession object.

6.6.1.5 Methods

The objects listed in this clause do not support any methods.

6.6.1.6 Events

The objects listed in this clause do not support any events.

6.6.1.7 Services

The objects listed in this clause do not support any services.

6.6.2 Altitude gain

Table 5 defines the attributes for the object that represents the sum of all altitude gained. This object may be supported by the agent.

Table 5—Altitude gain attributes

Attribute name	Value	Qual.
Handle	See IEEE Std 11073-20601.	M
Type	MDC_PART_PHD_HF MDC_HF_ALT_GAIN.	M
Metric-Spec-Small	mss-avail-intermittent mss- avail-stored-data mss-updt- aperiodic mss-msmt-aperiodic mss-acc-agent-initiated.	M
Measurement-Status	See IEEE Std 11073-20601.	O
Metric-Id	See IEEE Std 11073-20601.	O
Metric-Id-Partition	See IEEE Std 11073-20601.	O
Unit-Code	Valid values are MDC_DIM_X_M or MDC_DIM_X_FOOT.	M
Attribute-Value-Map	See IEEE Std 11073-20601.	C
Source-Handle-Reference	See IEEE Std 11073-20601.	M
Label-String	See IEEE Std 11073-20601.	O
Unit-LabelString	See IEEE Std 11073-20601.	O
Absolute-Time-Stamp	See 6.6.1.3.	C
Relative-Time-Stamp	See 6.6.1.3.	C
HiRes-Time-Stamp	See 6.6.1.3.	C
Simple-Nu-Observed-Value	See IEEE Std 11073-20601.	C
Basic-Nu-Observed-Value	See IEEE Std 11073-20601.	C
Nu-Observed-Value	See IEEE Std 11073-20601.	C
Compound-Nu-Observed-Value	See IEEE Std 11073-20601.	C
Accuracy	See IEEE Std 11073-20601.	O
Measure-Active-Period	See IEEE Std 11073-20601.	O

NOTE—See IEEE Std 11073-20601 for information on whether an attribute is static or dynamic.

The observed value reported in this object is the sum of all altitude gained. Only non-negative values shall be used, with zero (0) indicating that no altitude was gained.

6.6.3 Altitude loss

Table 6 defines the attributes for the object that represents the sum of all altitude lost. This object may be supported by the agent.

Table 6—Altitude loss attributes

Attribute name	Value	Qual.
Handle	See IEEE Std 11073-20601.	M
Type	MDC_PART_PHD_HF MDC_HF_ALT_LOSS.	M
Metric-Spec-Small	mss-avail-intermittent mss- avail-stored-data mss-updt- aperiodic mss-msmt-aperiodic mss-acc-agent-initiated.	M
Measurement-Status	See IEEE Std 11073-20601.	O
Metric-Id	See IEEE Std 11073-20601.	O
Metric-Id-Partition	See IEEE Std 11073-20601.	O
Unit-Code	Valid values are MDC_DIM_X_M or MDC_DIM_X_FOOT.	M
Attribute-Value-Map	See IEEE Std 11073-20601.	C
Source-Handle-Reference	See IEEE Std 11073-20601.	M
Label-String	See IEEE Std 11073-20601.	O
Unit-LabelString	See IEEE Std 11073-20601.	O
Absolute-Time-Stamp	See 6.6.1.3.	C
Relative-Time-Stamp	See 6.6.1.3.	C
HiRes-Time-Stamp	See 6.6.1.3.	C
Simple-Nu-Observed-Value	See IEEE Std 11073-20601.	C
Basic-Nu-Observed-Value	See IEEE Std 11073-20601.	C
Nu-Observed-Value	See IEEE Std 11073-20601.	C
Compound-Nu-Observed-Value	See IEEE Std 11073-20601.	C
Accuracy	See IEEE Std 11073-20601.	O
Measure-Active-Period	See IEEE Std 11073-20601.	O

NOTE—See IEEE Std 11073-20601 for information on whether an attribute is static or dynamic.

The observed value reported in this object is the sum of all altitude lost. Only non-negative values shall be used, with zero (0) indicating that no altitude was lost.

6.6.4 Altitude

Table 7 defines the attributes for the object that represents altitude. This object may be supported by the agent.