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First edition

Health informatics — Device interoperability —

Part 10206: Personal health device communication — Abstract content information model

Informatique de santé — Interopérabilité des dispositifs —

Partie 10206: Communication entre dispositifs de santé personnels — Modèle d'information de contenu abstrait

Reference number
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IEEE Std 11073-10206™-2022

Health Informatics—Device Interoperability—

Part 10206: Personal Health Device Communication—Abstract Content Information Model

Developed by the

IEEE 11073 Standards Committee
of the
IEEE Engineering in Medicine and Biology Society

Approved 21 September 2022

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Abstract: Within the context of the ISO/IEEE 11073 family of standards for device communication, a simplified framework for making an abstract model of personal health data is available in this standard. The specification addresses the structure and content of information. It does not address communication of the information between devices.

Keywords: device interoperability, IEEE 11073-10206™, personal health device communication

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Introduction

This introduction is not part of IEEE Std 11073-10206-2022, Health Informatics—Device Interoperability—Part 10206: Personal Health Device Communication—Abstract Content Information Model.

ISO and IEEE 11073 standards enable communication between medical devices and external computer systems. This standard addresses a need for a simplified content model that can be used for personal health devices and is not tied to a method of communicating the content model. This standard aligns with, and draws upon, the existing clinically focused standards as well as implementation experience gained over the past decade.

Other closely related standards include the following:

ISO/IEEE 11073-20601:2022, Health informatics—Device interoperability—Part 20601: Personal health device communication—Application profile—Optimized exchange protocol [B12].[6]

[6] The numbers in brackets correspond to those of the bibliography in Annex A.

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Health Informatics—Device Interoperability—

Part 10206: Personal Health Device Communication—Abstract Content Information Model

1. Overview

This standard defines an abstract content model (ACOM) for personal health devices (PHDs). The objective of this work is to document the information in a PHD and the content of health observations that are sent by the PHD so that when an observation is received from the PHD, regardless of the protocol used to perform the communication, the health information is complete, consistent, and unambiguous. This standard does not define a protocol by which information is exchanged between devices and hence does not make requirements on how concepts are represented. When specific representations are made herein the purpose is to provide clarity of concept.

1.1 Scope

This standard defines an object-oriented abstract information model to represent a PHD and the observations generated by a PHD. It specifies what information needs to be present and the relationships between the informational elements in the model. It models observations in a generic way by focusing on the information content contained in the presentation of health measurements. The modeling follows the practice of ISO/IEEE 11073-20601 [B12] where Unified Modeling Language (UML) is used to describe a set of objects and the relationship between the objects.[7] Tables provide descriptions of the attributes in the objects. IEEE 11073-10101™ nomenclature terms are used to express clinical content.[8] This standard provides guidance as to what an exchange protocols needs to communicate to properly represent health observations, but is not, in itself, sufficient to be an exchange protocol. However, the content model defined herein does have sufficient detail to help organizations validate that there is no loss of the semantic content induced by data exchanges in a protocol adhering to this standard. This standard does not define a security framework.

1.2 Purpose

This standard supports an ecosystem in which PHDs use the nomenclature and dictionary of IEEE 11073™. When the IEEE nomenclature is used it helps to ensure that data communicated by PHDs is clearly understood and useable by health professionals as well as intelligent systems in the wider digital health

[7] The numbers in brackets correspond to those of the bibliography in Annex A.

[8] Information on references can be found in Clause 2.

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ecosystem. In ISO/IEEE 11073-20601 [B12], which uses the IEEE 11073 nomenclature, the information model is integrated with an optimized data exchange mechanism. This standard seeks to establish a new, simplified information model that is independent of data exchange (such as physical or transport layer) dependencies. Further it seeks to reduce the breadth of objects and attributes in the information model based on implementation experience gained over the past ten years.

1.3 Word usage

The word *shall* indicates mandatory requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted (*shall* equals is *required to*).[9, 10]

The word *should* indicates that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required (*should* equals is *recommended that*).

The word *may* is used to indicate a course of action permissible within the limits of the standard (*may* equals is *permitted to*).

The word *can* is used for statements of possibility and capability, whether material, physical, or causal (*can* equals is *able to*).

1.4 Context

Figure 1 shows the categories and typical types of devices in the personal health space. *Personal health devices*, or PHDs (e.g., blood pressure monitors, weighing scales, and pedometers), collect information about a person (or persons) and transfer the information to a personal health gateway, or PHG (e.g., cell phone, health appliance, or personal computer) for collection, display, and possible later transmission. The PHG may also forward the data to remote support services for further analysis or to support disease management. The PHD may also send the data directly to remote support services. The information supports a range of domains including disease management, health and fitness, and aging independently.

The IEEE 11073 Personal Health Devices Working Group focuses on the information content and the data exchange between the PHDs and PHG and *remote support services* as shown in Figure 1. Within the overall IEEE 11073 context, this document concentrates on the information content of PHDs, with the objective of allowing the information to be used seamlessly across the healthcare ecosystem.

[9] The use of the word *must* is deprecated and cannot be used when stating mandatory requirements; *must* is used only to describe unavoidable situations.
[10] The use of *will* is deprecated and cannot be used when stating mandatory requirements; *will* is only used in statements of fact.

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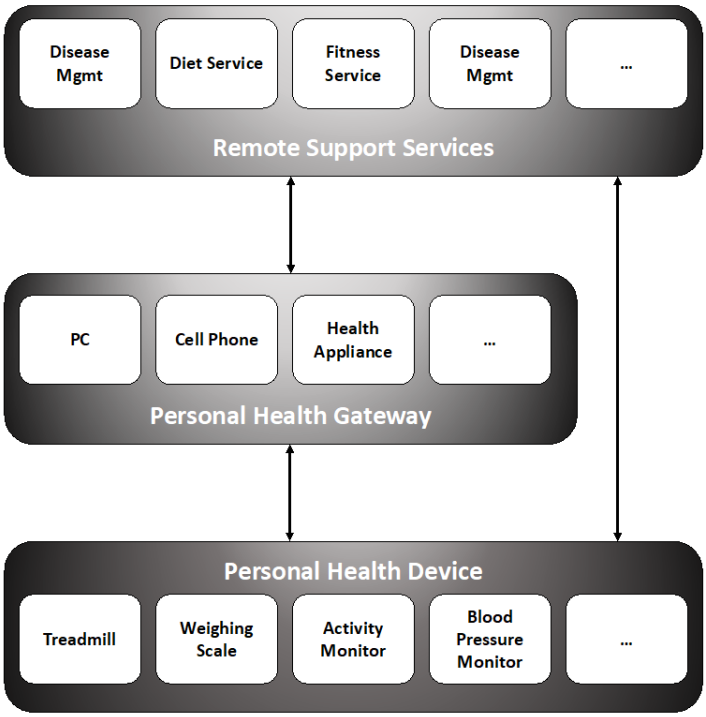

Figure 1—Overall context of work

2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so 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 11073-10101™-2019, IEEE Standard for Health informatics—Point-of-care medical device communication—Part 10101: Nomenclature.[11, 12]

IEEE Std 11073-10404™-2020, Health Informatics—Personal health device communication—Part 10404: Device specialization—Pulse oximeter.

IEEE Std 11073-10407™-2020, Health Informatics—Personal health device communication—Part 10407: Device specialization—Blood pressure monitor.

IEEE Std 11073-10408™-2019, Health Informatics—Personal health device communication—Part 10408: Device specialization—Thermometer.

IEEE Std 11073-10415™-2019, Health Informatics—Personal health device communication—Part 10415: Device specialization—Weighing scale.

[11] The IEEE standards or products referred to in Clause 2 are trademarks owned by The Institute of Electrical and Electronics Engineers, Incorporated.
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ISO/IEEE 11073-10406:2012, Health Informatics—Personal health device communication—Part 10406: Device specialization—Basic electrocardiograph (ECG) (1- to 3-lead ECG). [13]

ISO/IEEE 11073-10417-2017, Health Informatics—Personal health device communication—Part 10417: Device specialization—Glucose Meter.

3. Definitions, acronyms, and abbreviations

3.1 Definitions

For the purposes of this document, the following terms and definitions apply. The *IEEE Standards Dictionary Online* should be consulted for terms not defined in this clause. [14]

attribute: An attribute is an element in a class definition that describes a property or capability of the associated object that the class instantiates.

civil time: The statutory time scales as specified by governmental or civilian authorities. Civil time is typically standard time with a possible adjustment for daylight savings time.

class: As used in programming languages, an extensible template that defines the structure of objects.

NOTE—As used in this standard, *classes* capture the information content of the different components in the abstract information model. [15]

Coordinated Universal Time (UTC): The primary standard for expressing time in a precise, accurate, and unambiguous manner. UTC reports the solar mean time at 0º longitude.

device: A physical device implementing either a personal health device (PHD) or personal health gateway (PHG) role.

local time: The time in a given location based on the apparent movement of the sun due to the earth's rotation. Local time changes with longitude. Local time is often misused to mean *civil time*.

measurement: A datum generated by a personal health device (PHD), which is typically a reading from a sensor or the output of a counter.

object: The result of the instantiation of an abstraction, such as a class template.

NOTE—As used in this standard, the information content of an object can be understood through the associated class definition.

observation: Information associated with a measurement generated by a personal health device (PHD). An observation provides a more complete understanding of a measurement. By way of example, a temperature observation contains the numerical reading of a temperature sensor, the units of measure, and the time at which the sensor was read.

[13] ISO publications are available from the International Organization for Standardization (https://www.iso.org/) and the American National Standards Institute (https://www.ansi.org/).
[14] *IEEE Standards Dictionary Online* is available at: http://dictionary.ieee.org. An IEEE Account is required for access to the dictionary, and one can be created at no charge on the dictionary sign-in page.
[15] Notes in text, tables, and figures of a standard are given for information only and do not contain requirements needed to implement this standard.

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partition: A division of the code space of IEEE Std 11073-10101 that provides for independence of numbering within logically related areas.

personal health device (PHD): A device that generates observations used in applications related to personal health. A common PHD is a blood pressure cuff.

personal health gateway (PHG): An entity receiving data from one or more personal health devices (PHDs). PHGs may be logical components internal to either a PHD or in a remote support service. A PHG can also be implemented in a range of different platforms including cellular phones, tablets, purpose-built appliances, set-top boxes, and personal computers.

NOTE—Exchange protocols that support this standard will generally proscribe methods to move observations between a PHD and a PHG.

standard time: A fixed time for a given meridian established by law for a given country. Multiple meridians may have the same standard time that has been established by civil authorities. Standard time does not include adjustments for daylight savings time.

time of day (TOD) time: A form of time that can either be Coordinated Universal Time (UTC) or civil time. TOD time requires a personal health device (PHD) to indicate the use of UTC or civil time, its support for time zones, and its support for daylight savings time.

3.2 Acronyms and abbreviations

ACOM	Abstract COntent Model
API	application programming interface
ASCII	American Standard Code for Information Interchange[16]
ASN.1	Abstract Syntax Notation One
AVA	attribute value assertion
DIM	domain information model
DST	daylight savings time
ECG	ElectroCardioGram or electrocardiograph
ENUM	ENUMeration
EUI-64	Extended Unique Identifier (64 bits)
FHIR	Fast Healthcare Interoperable Resource
GMDN	Global Medical Device Nomenclature
ID	Identifier
MDC	medical device communication
MDS	medical device system
NaN	not a number
OID	Object IDentifier
OUI	organizationally unique identifier
PHD	personal health device

[16] Note that throughout this standard the term *ASCII* is used to mean the character set as defined in ISO/IEC 646:1991 [B14].

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PHG	personal health gateway
TOD	time of day time
UTC	Coordinated Universal Time
UUID	universally unique identifier

4. Guiding principles

This standard and the other PHD standards fit in the larger context of the ISO/IEEE 11073 family of standards. The full suite of standards enables PHDs to interconnect and interoperate with PHGs and with computerized healthcare information systems.

The information model defined in this standard considers the nature of PHDs and how they are used, which is often outside a clinical setting, e.g., body-worn or in a person's home. Some of the defining characteristics are as follows:

a) PHDs often have limited computing capabilities.

b) PHDs often have a fixed configuration and are used in conjunction with a single PHG.

c) PHDs are frequently battery powered, body-worn devices, using a wireless communication link.

d) Health information is increasingly collected outside of the clinical setting. This information will be used by individuals concerned about fitness and performance, by care providers supporting independent living, and by clinical professionals managing disease states. It is essential that this collected data is clear and appropriate.

The ISO/IEEE 11073 family of standards is based on an object-oriented paradigm; a medical device is modelled by a series of class definitions and the associated attributes that represent the information of separate aspects of the device. The information provided by individual sensors within a device is modeled by attributes of the observation class and its sub classes.

This standard leverages the concepts of the ISO/IEEE 11073 family of standards and seeks to provide a model that is simplified from that of ISO/IEEE 11073-20601 [B12]. This standard describes the content of the most commonly used types of PHDs but other less common PHDs and future PHDs should be able to leverage this work. In addition, this standard has been developed to be independent of the technology used to communicate information between PHD and PHG.

NOTE— This standard will be under constant review and will be revised to support newly emerging requirements.

5. Introduction to IEEE 11073 personal health device

The overall ISO/IEEE 11073 architecture comprises three principal components: the domain information model (DIM), the service model, and the communications model. This standard models the information content on a PHD, which is the DIM component in the ISO/IEEE 11073 architecture. There is no service or communications model.

5.1 Content information model

Abstract content model (ACOM) describes the information of a PHD through a set of Object Management Group (OMG) Unified Modeling Language (UML 2.0) [B20] diagrams, class definitions, and tables of associated attributes. Attributes describe specific properties of the PHD and its observations. ACOM is abstract in that the content information model does not document a normative encoding or method of exchange. Technical specifications that claim to support ACOM must only ensure that the entity receiving the protocol exchanges is able to reconstruct the observations, devices, and relationships between them as

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documented in this standard. It shall be possible for the receiving entity to map to the IEEE nomenclature codes that are used herein to define health-related content.

5.2 Compliance with other standards

Devices that comply with this standard may also be required to comply with other domain- and device-specific standards that supersede the requirements of this standard with respect to issues including safety, reliability, and risk management. A user of this standard is expected to be familiar with all other such standards that apply and to comply with any higher specifications thus imposed. Typically, medical devices will comply with the IEC 60601-1 (2005) +A1 (2012) [B7] base standards with respect to electrical and mechanical safety, and any device-specific standard as might be defined in the IEC 60601-2 [B8] series of standards. Software aspects may apply through standards such as IEC 62304:2006/EN 62304 (2006) [B9].

Devices that comply with this standard utilize software stacks on various digital platforms as appropriate to the application. The requirements on performance of such applications and conformance are defined elsewhere and are outside the scope of this standard. Moreover, the use of any medical equipment is subject to risk assessment and risk management appropriate to the application. Relevant examples are ISO 14971:2007 [B13] and IEC 80001-1 (2010) [B10]. The requirements of such risk assessment and risk management and conformance are outside the scope of this standard.

5.3 Security

Security is out of scope and must be considered in the context in which this standard is used.

5.4 Background

This standard defines the semantic content of measurements generated by PHDs and some of the properties associated with those devices. As used herein the phrase *semantic context* implies “what” is to be represented. It does not address how the information is to be represented within a digital system or how a protocol is to exchange the information. Standardizing what information makes up a health observation allows there to be consistency in device data across a multiplicity of devices that may generate different types of observations and use different communication technologies to exchange that information. The information content described herein could be represented by an HL7 V2 message (see HL7 Messaging Standard [B6]), a Fast Healthcare Interoperable Resource (FHIR) JSON structure (see HL7 FAIR [B5]), a CDA XML document (see ANSI/HL7 V3 RIM:R6-2013 [B1]), or a IEEE 11073 MDER-encoded ASN.1 9 {see ISO/IEEE 11073-20101:2004 [B18], ITU-T Rec. X.680 (07/2002) [B19]} structure in binary. However, in each case, the semantic content of the exchanged information would be the same.

By way of example, a temperature observation consists of a numeric value, a unit of measure, and a timestamp. A glucose concentration observation also consists of a numeric value, a unit of measure, and a timestamp. In fact, there are several observations that consist of the same three components. The current practice in standardizing these observations is to create a separate model for each type of measurement device. The downside of the current practice is that it is specific to each type of device and should a new one be needed, a new specification needs to be defined and new software needs to be written to handle it.

This standard addresses the problem of supporting many device types by defining a content model based on commonly used concepts for describing measurement values in a compositional framework. The compositional approach fosters the development of extensible systems since those systems only need to support the base components used to building the observations. This is particularly important for devices acting as PHGs since PHGs are often infrastructure components in a healthcare network that need to support a range of PHDs in a changing environment.

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5.4.1 Modeling the observation

The semantic content of an observation defined herein is expressed using the IEEE 11073-10101 nomenclature coding system. The IEEE nomenclature terms provides the rich set of well-defined, precise concepts recognized by the biomedical science communities. These codes are used in both the model of the device and the model of the observation. Note that an exchange protocol can use other coding systems but must provide or reference a mapping, in the public domain, of the chosen coding system to the IEEE nomenclature codes.

For a simple numeric observation such as the temperature the nomenclature terms are used to express the following:

— What type of measurement it is (e.g., rectal temperature)

— What the value of the measurement is (e.g., 36.0)

— What the unit of measurement is (e.g., Celsius)

— When the measurement was taken (timestamp) and the characteristics of the timestamp

Some observations cannot be represented by a single numeric value. For example, an acceleration measurement contains x, y, and z components and a blood pressure measurement contains systolic, diastolic, and sometimes mean components. In such a situation it is often desirable to aggregate the different components into a single observation to capture the close coupling between the components. This standard provides the Compound Observation class (see 7.16) for this purpose. The Compound Observation class supports a set of components where each component can have its own unique type. The following points provide guidance for when to use components in Compound Observation class and when to use another Observation class:

— The Compound Observation is used when the observed value of a measurement cannot be fully interpreted and used outside the scope of additional components of the measurement. Components may by themselves represent a meaningful measurement or may only be meaningful in the context of other components of the observation. Both the type and value of the component need to be considered to fully understand the meaning the component has in relation to the overall observation. Components should be used when there is only one method of measurement being employed to obtain the values, are all part of one observation, are produced by the same device, and have a common time. Some use cases for component are:

  — Measurements that are commonly produced and interpreted together. For example, systolic and diastolic blood pressure are represented as components of a single blood-pressure-observation.

  — Observations with components that have full significance when reported together. For example, a patient position and the percentage of the observation period in which the patient was observed to be in that position are reported together as a Patient-posture-over-time Observation.

  — Observations with a component that determines the meaning of another component. For example, a forced vital breathing capacity measurement is measured by a spirometer and compared to a predicted value from a commonly used model. The z-score (number of standard deviations away from the model), a percentage (compared to the model), and the lower level of normal (in the model) can be reported as components with a discrete or String component for the model itself.

— When any measurement is clinically relevant outside the context of being a component of another observation it should be represented as a separate Observation. For example, a Body Mass Index (BMI) Observation should not contain components for height and weight because they are clinically relevant observations on their own and should be represented by separate Observation resources. The hasMember and derivedFrom attributes of the Observation class are used for any supporting result that can be interpreted and used on its own and has one or more different values for method,

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observation, device, time, and/or error conditions. Two common use cases for using this structure are as follows:

— For grouping related observations over a period of time such as in an exercise "session." In this case the type represents the exercise session type, typically the Observation reports the type of a panel or session (e.g., for spirometry a forced expiration session consists of several forced vital capacity observations), and the set of member Observations are listed in Observation.hasMember.

— When linking to other Observations from which an Observation is derived. The linked observations are listed in Observation.derivedFrom. An example of this would be a Body Mass Index (BMI) Observation where the height and weight measurements are referenced.

The ACOM Observation class supports different ways in which the value of a measurement can be modeled, as follows:

— A single numeric: ACOM simple numeric observation class.

— A compound: ACOM compound observation class.

— A sequence of periodic samples (e.g., waveforms): ACOM sample array observation class.

— An event coming from a defined set of possible events: ACOM simple event observation class.

— A list of binary states (heat on/off, window open/closed, door open/closed, patient in/out of room): ACOM compound Boolean state observation class.

— A list of events: ACOM Compound event observation class.

— A human readable string (such as the program name on a piece of gym equipment): ACOM string observation class.

There are measurement value types that are not covered by these models, some examples are X-ray images, spatial and spectral transforms. These are sometimes used in point-of-care devices but are currently out of scope for PHDs.

The ACOM model specifies features the PHD needs to support to help assure accurate understanding of the observation. One of these features is the timestamp. Time is important in understanding the observation and timestamps are required whenever a measurement is stored on the PHD. The subject of time and timestamps is covered in 6.3.

An additional complexity arises due to the different types of time a PHD can support. Most PHDs support the concept of civil time; that is, they are meant to be used in a single time zone, and when communicating with a PHG, both devices are anticipated to be in the same location. The ACOM Clock class is designed to allow the PHD to model its time-related capabilities.

The reader should note that this standard defines an abstract content model. It cannot be implemented in an interoperable manner outside of the context of some additional specifications. As such, its primary use is to define the information content that should be provided in a health observation as a starting point for writers of such additional technical specifications. See 6.3 for additional details

6. Content information model concepts

The standard does not require a particular method of presentation of the concepts that are described herein. However, abstract concepts are documented using the IEEE coding system, basic data types are specified, specific UML classes defined, and time is described in the context of a particular representation. When these concrete representations are used, it is only to foster a better understanding of the model. This standard does not require that these representations be used in exchange protocols adhering to this standard.

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In particular, while the information model of this standard is defined using object-oriented techniques, this does not imply that object-oriented technologies (e.g., object-oriented programming languages) need to be used to implement this standard.

6.1 Nomenclature usage

The content information model defined in this standard uses nomenclature terms that are primarily specified in either IEEE Std 11073-10101-2019 or ISO/IEEE 11073-20601 [B12]. The use of the IEEE coding system, or an unambiguous equivalent representation that is in the public domain and can be mapped to the IEEE coding system, shall be required by a protocol claiming conformance to this standard, as it is foundational to maintaining semantic correctness of clinical information. Additionally, this standard defines nomenclature terms that begin with the ACOM_ prefix. ACOM_ prefixed nomenclature terms are defined herein and are used for consistency in documentation of the UML classes. When a nomenclature term is prefixed by ACOM_ the term is not expected to be used in an exchange protocol and should not appear in downstream information content.

Each defined class in this standard has a table with a column entitled “Related nomenclature.” When nomenclature exists that is related to this attribute, the nomenclature terms are listed in the corresponding cell of the table. The nomenclature terms are sometimes related to a specific clinical concept and that concept must be communicated precisely in the exchange protocol. In other cases, the nomenclature term is there to support understanding of the classes and how they relate to each other. In this situation there is no specific requirement placed on an exchange protocol.

Nomenclature codes for attributes taken from ISO/IEEE 11073-20601 [B12] are often tied to specific representations for the associated attribute values based on the ASN.1 definition of these attributes. When nomenclature terms for attributes are referenced in this standard, the reference is intended to communicate the semantic meaning of the attribute. The associated representation is not implied. When there is semantic content based on the ASN.1 definition of the attribute, the required semantic information will be documented in the associated table entry for the attribute.

6.1.1 Nomenclature codes

The nomenclature code in each context-dependent partition is defined, and can be referenced, by a 16-bit code, called a *partition code*, that supports up to 65536 independent terms per partition. 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 the full 32-bit context free code is constructed by concatenating the 16-bit partition code with the 16-bit term code. Table 1 shows the partitions that are defined in IEEE Std 11073-10101-2019.

Term codes from partition 1024 and term codes from 0xF000 to 0xFFFF in each partition in the nomenclature are reserved for private (vendor-specified) nomenclature codes.

For each nomenclature term, IEEE Std 11073-10101 defines a systematic name that explains the term, a unique code value, and a reference identifier (ID). The reference ID has the form MDC_ followed by a descriptive string (with MDC referring to “medical device communication”). An example of a reference ID for an MDC term is MDC_MASS_BODY_ACTUAL.

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Table 1—Partitions in the nomenclature

Partition number	Nomenclature category
0	Unspecified
1	Object-oriented
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	File Exchange Format
10	Electrocardiogram (ECG) Extensions
11	Implantable Device Cardiac Observations (IDCO) Extensions
12–127	Reserved
128	Personal health 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
1025–65535	Reserved

6.2 Data types

The following basic data types are used for the attributes in the ACOM UML classes. Note that as with all aspects of ACOM, we do not define a presentation of these types, but we do define the semantics. Each ACOM attribute has a well-defined data type that defines the possible values an attribute can have. This standard documents a set of common primitive data types that are not further refined as their semantic meaning is common knowledge.

Data types are different from classes in the sense that they are identified by their value and, in this standard, are not identified by a term code. Data types define the value sets for attributes in the model.

The primitive data types in Table 2 are used in ACOM UML models as they are widely understood and do not need to have further decomposition to understand them. As a reminder the data types used here do not necessitate their use in an exchange protocol.

Table 2—Primitive data types

Data type	Semantic
term	A term identifies a particular semantic concept.
reference	A reference provides a pointer or link to another object.
string	A human readable sequence of characters.
integer	An integer number: in typical implementations limited to some suitable range.
Boolean	True or false
real	A real number: in typical implementations limited to some range and some precision.
byte	An 8-bit value without further semantics.
dateAndTime	A moment in time usually defined by year, month, day, hour, minutes, seconds, and when desired fractions of a second. Can be coded in various forms.

6.2.1 Compositions—compound data types

UML and ACOM support the following compositions of data types into more complex structures:

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— A data type can be composed of a set of data type attributes, each defined by a name and a data type. Example: SpecTypeAndVersion is composed of a spec-type with a term value and a version with an integer value.

— A data type attribute has a cardinality, just as a class attribute indicating how often the attribute can occur. The default cardinality is 1. Examples:

  — serial-number: string[0..1]—This defines an optional serial number attribute with a String as value

  — observation-types-list: term[0..*]—This defines an observation-types-list attribute with a set of zero or more Terms as values.

— When a cardinality different from 0 or 1 is used, the attribute defines either a set or a sequence of values. In a set the order of the elements has no meaning. In a sequence the order has meaning. The default is to define a set. For a sequence this is indicated explicitly with {sequence}: value: byte[0..*] {sequence}

6.2.2 Enumerations

An enumeration is a data type with all possible values explicitly defined.

In this standard there is no explicit encoding or mapping required for representing the possible values in the enumeration to the integer or byte values. It is recommended to have an IEEE-defined code for each element of the enumeration. An example for the use of enumeration types would be an activity monitor session activity type such as walk, run, swim, bike, etc. The activity monitor might define separate sessions for each activity type and report the statistics of that particular activity.

The term codes for possible activity types are as follows:

{

MDC_HF_ACT_AMB
MDC_HF_ACT_REST
MDC_HF_ACT_MOTOR
MDC_HF_ACT_LYING
MDC_HF_ACT_SLEEP
MDC_HF_ACT_PHYS
MDC_HF_ACT_SUS_PHYS
MDC_HF_ACT_UNKNOWN
MDC_HF_ACT_MULTIPLE
MDC_HF_ACT_MONITOR
MDC_HF_ACT_SKI
MDC_HF_ACT_RUN
MDC_HF_ACT_BIKE
MDC_HF_ACT_STAIR
MDC_HF_ACT_ROW
MDC_HF_ACT_HOME
MDC_HF_ACT_WORK
MDC_HF_ACT_WALK}

A common type of activity monitor is a step counter where the activity type would be MDC_HF_ACT_WALK. Such a monitor might define sessions that last for fixed periods of time such as an hour or a day and record the statistics for each of the sessions. Common statistics reported are the number of steps taken, distance traveled, amount of time spent within the session of doing the activity, and calories burned.

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6.2.3 General purpose data types

The general purpose data types shown in Table 3 are used multiple times in the model:

Table 3—General purpose data types

Data type	Semantic
Boolean State	An expression of state that can be represented as either true or false
EUI-64	An Extended Unique Identifier defined and administered by the IEEE, used to identify network interfaces or device instances
Integer Range	A delineated contiguous subset of integer values
OID	An identifier assigned by either ISO or the joint ISO-ITU to identify organizations responsible for assigning numbers
Real Range	A delineated, contiguous subset of real numbers
DST	Daylight Savings Time—Indicates if the device adjusts the clock in accordance with DST rules.
Duration	The elapsed time between two events
Observation-component	A value reported in an observation that is a portion of the observation but is not the complete observation. An example of an observation-component is the rate of acceleration in the X dimension of an acceleration observation. See 5.4.1 for a discussion on when to use an observation-component.
Observation status code	Provides information about the validity of the data; designed to foster a better understanding of the usability of the data. Defined values are as follows: — invalid—The PHD has indicated that the measurement value should not be trusted — questionable—The PHD has indicated that there are reasons for concern relating to the measurement — not-available—At the time the observation report was generated by the PHD a value was not-available. The observation value field in this case is normally set to indicate that it is “Not-A-Number.” — calibration-ongoing—The value was measured during a calibration procedure — test-data—The value reported is generated by test conditions — early-indication—An early estimate of a value — calculation—The value reported is not a direct measurement from a sensor but a calculated value that is either derived from direct measurements or manually entered. — msmt-ongoing—Another measurement is in process and its outcome may impact this measurement or be relevant to this measurement — msmt-value-exceeded-boundaries—Indicates that the measurement is outside threshold boundaries set for the measurement — msmt-state-ann-inhibited—Threshold indication is disabled on the PHD and should not cause an annunciation. When this condition is reported the msmt-value-exceeded-boundaries is to be ignored — setting—The observation is a reporting of a setting on the device — manually entered—The observation value was manually entered through a UI

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