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SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS

E-health multimedia services and applications – Personal health systems

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# Interoperability design guidelines for personal health systems: Services interface: Observation upload certified capability class

Recommendation ITU-T H.812.1

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ITU-T H-SERIES RECOMMENDATIONS

**AUDIOVISUAL AND MULTIMEDIA SYSTEMS**

| | |
|---|---|
| CHARACTERISTICS OF VISUAL TELEPHONE SYSTEMS | H.100–H.199 |
| INFRASTRUCTURE OF AUDIOVISUAL SERVICES | |
| General | H.200–H.219 |
| Transmission multiplexing and synchronization | H.220–H.229 |
| Systems aspects | H.230–H.239 |
| Communication procedures | H.240–H.259 |
| Coding of moving video | H.260–H.279 |
| Related systems aspects | H.280–H.299 |
| Systems and terminal equipment for audiovisual services | H.300–H.349 |
| Directory services architecture for audiovisual and multimedia services | H.350–H.359 |
| Quality of service architecture for audiovisual and multimedia services | H.360–H.369 |
| Telepresence | H.420–H.429 |
| Supplementary services for multimedia | H.450–H.499 |
| MOBILITY AND COLLABORATION PROCEDURES | |
| Overview of Mobility and Collaboration, definitions, protocols and procedures | H.500–H.509 |
| Mobility for H-Series multimedia systems and services | H.510–H.519 |
| Mobile multimedia collaboration applications and services | H.520–H.529 |
| Security for mobile multimedia systems and services | H.530–H.539 |
| Security for mobile multimedia collaboration applications and services | H.540–H.549 |
| Mobility interworking procedures | H.550–H.559 |
| Mobile multimedia collaboration inter-working procedures | H.560–H.569 |
| BROADBAND, TRIPLE-PLAY AND ADVANCED MULTIMEDIA SERVICES | |
| Broadband multimedia services over VDSL | H.610–H.619 |
| Advanced multimedia services and applications | H.620–H.629 |
| Ubiquitous sensor network applications and Internet of Things | H.640–H.649 |
| IPTV MULTIMEDIA SERVICES AND APPLICATIONS FOR IPTV | |
| General aspects | H.700–H.719 |
| IPTV terminal devices | H.720–H.729 |
| IPTV middleware | H.730–H.739 |
| IPTV application event handling | H.740–H.749 |
| IPTV metadata | H.750–H.759 |
| IPTV multimedia application frameworks | H.760–H.769 |
| IPTV service discovery up to consumption | H.770–H.779 |
| Digital Signage | H.780–H.789 |
| E-HEALTH MULTIMEDIA SERVICES AND APPLICATIONS | |
| **Personal health systems** | **H.810–H.819** |
| Interoperability compliance testing of personal health systems (HRN, PAN, LAN, TAN and WAN) | H.820–H.859 |
| Multimedia e-health data exchange services | H.860–H.869 |

*For further details, please refer to the list of ITU-T Recommendations.*

# Recommendation ITU-T H.812.1

## Interoperability design guidelines for personal health systems: Services interface: Observation upload certified capability class


### Summary

The Continua Design Guidelines (CDG) defines a framework of underlying standards and criteria that ensure the interoperability of devices and data used for personal connected health services. It also contains additional design guidelines (DGs) that further clarify the underlying standards or specifications by reducing the options or by adding missing features to improve interoperability.

This specification defines the additional design guidelines for the Observation Upload Certified Capability Class (CCC), whose function is to transfer an observation measurement from a medical device to a services application over the services interface (Services-IF).

Recommendation ITU-T H.812.1 is part of the "ITU-T H.810 interoperability design guidelines for personal connected health systems" subseries that covers the following areas:

– ITU-T H.810 – Interoperability design guidelines for personal connected health systems: System overview
– ITU-T H.811 – Interoperability design guidelines for personal connected health systems: Personal health devices interface design guidelines
– ITU-T H.812 – Interoperability design guidelines for personal connected health systems: Services interface design guidelines
– ITU-T H.812.1 – Interoperability design guidelines for personal connected health systems: Services interface: Observation Upload capability
– ITU-T H.812.2 – Interoperability design guidelines for personal connected health systems: Services interface: Questionnaires capability
– ITU-T H.812.3 – Interoperability design guidelines for personal connected health systems: Services interface: Capability exchange capability
– ITU-T H.812.4 – Interoperability design guidelines for personal connected health systems: Services interface: Authenticated persistent session capability
– ITU-T H.813 – Interoperability design guidelines for personal connected health systems: Healthcare information system interface design guidelines



## History

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## FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

## Table of Contents

Page

Page

## List of Tables

Page

Page

## List of Figures

**Page**

## 0 Introduction

The Continua Design Guidelines (CDG) defines a framework of underlying standards and criteria that ensure the interoperability of devices used for applications monitoring personal connected health services. It also contains additional design guidelines (DGs) that further clarify the underlying standards or specifications by reducing options or by adding missing features to improve interoperability.

This Recommendation defines the design guidelines for the Observation Upload Certified Capability Class (CCC), whose function is to transfer an observation measurement from the Personal Health Gateway (PHG) to a health and fitness application over the services interface (Services-IF).

This Recommendation is part of the [ITU-T H.810] sub-series "H.810 interoperability design guidelines for personal health systems" sub-series. See [ITU-T H.810] for more details.

### 0.1 Organization

This Recommendation is organized in the following manner:

**Clauses 0-5**: **Introduction and terminology** – These clauses provide overview information to help understand the structure of the design specifications.

**Clause 6**: **Use cases** – This clause provides practical examples.

**Clause 7**: **Behavioural model** – This clause provides an overview of sequences of interactions and summarizes typical iterations, constraints and exceptions.

**Clause 8**: **Implementation guidance** – This clause provides an informative description of the implementation of the Observation Upload CCC.

**Clause 9**: **PCD-01 background** – This clause provides an informative description of the PCD-01 document.

### 0.2 CCC guideline releases and versioning

See clause 0.2 of [ITU-T H.810] for release and versioning information.

### 0.3 What's new

To see what is new in this release of the design guidelines refer to clause 0.3 of [ITU-T H.810].

# Recommendation ITU-T H.812.1

## Interoperability design guidelines for personal health systems: Services interface: Observation upload certified capability class

## 1 Scope

This Recommendation defines design guidelines for the Observation Upload CCCs which are designed to allow the transfer of an observation measurement from a PHG to a services application over the services interface (Services-IF) in a secure and interoperable way.

## 2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T H.810] Recommendation ITU-T H.810 (2016), *Interoperability design guidelines for personal health systems*.

All other referenced documents can be found in clause 2 of [ITU-T H.810].

## 3 Definitions

This Recommendation uses terms defined in [ITU-T H.810].

## 4 Abbreviations and acronyms

This Recommendation uses abbreviations and acronyms defined in [ITU-T H.810].

## 5 Conventions

This Recommendation follows the conventions defined in [ITU-T H.810].

## 6 Observation Upload use case

The Observation Upload use case is focused on the needs identified for transferring patient observation measurements to a server.

Observation Upload can be achieved using either of two methods defined in clause 7 of this design guideline; the choice of which method to use is left to the implementer.

### 6.1 Observation Upload to the server

Angus has decided that he wishes to improve his general fitness levels after a checkup with his General Practitioner showed that he was becoming overweight and that this could impact his long term health. After some research he decides to sign up to an online service that allows him to use his current smartphone and some additional devices to monitor many of his physical activities.

Initially he tracks his cycle rides using an application on his smartphone which in turn uploads the data collected to the online service.

Angus is also tracking his weight and heart rate using Continua certified devices that allow him to upload his weight and standing heart rate, both pre and post activity to his service provider that hosts the web application where all his daily measurements are stored.

Having these measurements hosted on a website allows him to track progress over time, share highlights with his social circle and compete against friends.

### 6.1.1 Chosen standards and profiles

The Continua services interface (Services-IF) defines a set of interoperable message exchanges between a Services observation sender device and a Services observation receiver. From a high level perspective, these guidelines describe protocol transactions by characterizing the protocol exchange framework and the format of the contained information. The protocol exchange framework describes the required protocol stack and security mechanisms that are used to exchange the data of the protocol.

Devices implementing the Services-IF using SOAP must use the transport guidelines found in Appendix V of [IHE ITI-TF-2] and devices using hData must use guidelines found in clause 7.2 as the message exchange framework, formatting the contained information in accordance with the IHE PCD-01 transaction of the IHE device to the enterprise communication profile in the IHE patient care devices technical framework.

### 6.1.2 Data payload

The information contained in the data payload must be formatted in accordance with the IHE PCD-01 transaction: Communicate PCD Data. The patient care device (PCD) technical framework constrains the use of HL7 V2.6 messages, requiring that observations be exchanged using the unsolicited observation result message (ORU^R01^ORU_R01).

The choice of adopting the IHE PCD-01 transaction was motivated by a number of considerations:

The PCD-01 transaction allows the use of common nomenclature, defined by the [ISO/IEEE 11073] committee, for all devices. Continued use of this nomenclature over the services interface simplifies the operation of the PHG, as it is unnecessary to maintain accurate and up to date code translation tables on the PHG. All observation identifiers are based on the terms in [ISO/IEEE 11073-20601], [IEEE 11073-20601A] and the related X73 documents.

Continua addresses the needs of three distinct market segments in remote health monitoring; health and fitness, ageing independently and disease management. The form in which data is represented over the services interface had to be inclusive of personal health devices that are used in each of these market segments. Given the IHE patient care device team's existing work of mapping X73 devices to HL7 observation result messages and some initial groundwork by the Continua services interface sub-team, it was deemed that the PCD-01 transaction is capable of supporting personal health devices for all three market segments. Furthermore, the PCD-01 transaction is based on HL7 V2.6 [HL7 2.6] and has been shown to be effective in the clinical environment, providing strong evidence that it will be capable of supporting additional Continua use cases and devices in the future.

The PCD-01 transaction has an existing user base and the IHE PCD domain is actively working to validate interoperability based on compliance with this transaction, as well as defining new profiles for related use cases.

The PCD-01 unsolicited observation result provides a well-defined, self-contained message uniform for transmitting one or more observations enabling less stateful message exchange between the Services observation sender and receiver which improves scalability.

HL7 V2.6 messages are supported by the HL7 Messaging Workbench and National Institute of Standards and Technology (NIST) test tooling found at http://transport-testing.nist.gov/.

One of the motivations for using the HL7 V2.6 messaging structure as opposed to the HL7 V3.0 data representations was the reduction in bandwidth achieved with the more compact HL7 V2.6 messaging structure.

### 6.1.3 Services protocol (informative)

The Continua services interface (Services-IF) consists of data payload and message exchange framework protocols that are designed to operate across a wide area network. In particular, the Continua services interface is specified to run over standard private and public TCP/IP networks, such as the Internet. The Continua services interface does not offer guidelines on the physical, data link or network layers of this network, but does provide detailed guidance on the transport, presentation and application to be used for interoperable communications. There may be specific performance criteria for the underlying network layers, such as message delivery latency, message error rates and message delivery reliability that affect the robust operation of the Continua services interface that must be taken into account through system-level design. Mechanisms for assurance that such minimum network performance metrics are obtained in any given implementation are beyond the scope of this design guideline and are well documented within networking literature.

# 7 Behavioural models

The following exchange mechanisms are specified for the Observation Upload service:

– Create a new observation measurement on the uploader using SOAP.

– Create a new observation measurement on the uploader using hData.

The services interface requires that all connections be initiated from the services sender device for the Observation Upload CCC. The services Observation Upload sender and receiver are required to use transport level security (TLS) for point to point content security. Whether or not the services Observation Upload receiver additionally requires mutual certificate validation in the TLS handshake is up to policy. The services Observation Upload sender is also required to provide an indication that it has been authenticated and that it is authorized to perform this transaction. In the SOAP case, this indication is an SAML 2.0 token and for hData an OAuth 2.0 Bearer token. How the services Observation Upload sender obtains these tokens is not specified by Continua. It depends upon the trust relationship established between the parties. The services Observation Upload receiver may support one or more WS-Trust options to obtain SAML 2.0 tokens or it may support an OAuth 2.0 authorization framework server using one or more grant types, for example the resource owner password credentials grant type. The services Observation Upload receiver may support both if it supports both hData and SOAP uploads. In either of these cases an out-of-band operation must take place where the user of the services Observation Upload sender establishes some type of account on the receiver allowing the client to obtain these tokens. The observation receiver token service generates these tokens customized for the recipient which it can validate when it receives the upload. On the other hand, the services Observation Upload receiver may require that these tokens be obtained from a third party authorization service (such as a certification authority) with which the services Observation Upload receiver has established a trust relationship. In this case the services Observation Upload receiver is letting the third party authorization service do the leg work of authenticating the client. The services observation receiver may then choose to accept any token that comes from this third party service or it may additionally choose to pass the received token to this service for confirmation before acceptance. The trust relationship details are determined by policy but in all cases Continua requires that Observation Uploads are point to point secure and that the client indicates that it has been authenticated and is thereby authorized to perform the transaction.

## 7.1 SOAP implementation

### 7.1.1 Observation Upload using SOAP

The Continua Services interface uses a web service transport layer defined in Appendix V of [IHE ITI-TF-2], which specifies the usage of SOAP 1.2 over HTTP version 1.1 and otherwise conforms to the Web Services Interoperability Organization's Basic Profile Version 1.1 [OASIS/WS-I BP] and Basic Security Profile 1.0 [OASIS/WS-I BSP]. The services message exchange framework further specifies conformance to the Reliable Secure Profile [WS-I RSP] to constrain the optional use of additional web service standards.

This message exchange framework is motivated by the availability of client and server implementations and a need to ensure the scalability of services observation receiver devices. It was further impacted by a number of additional considerations:

– the desire to have a capable and comprehensive security architecture that is well understood;
  - o The WS-I Basic Security Profile has undergone significant industry vetting and provides the flexibility needed to support both a simple secure tunnel as well as more involved security models.
– the need to operate across firewalls when the services observation sender device and services observation receiver device are in different administrative domains of control;
– the need to support a reliable connection over multiple instances of a transport connection which spans both the time domain, as well as cooperating software layers and modules in a back-end service environment;
  - o Using [OASIS WS-I BSP] as a base allows for the accommodation of these concerns through the additional use of the WS-ReliableMessaging and WS-MakeConnection web service standards.

The transport portion of the Continua services interface (Services-IF) is based on a set of web service standards defined by IETF, W3C and OASIS as profiled by the IHE IT infrastructure technical framework, the WS-I Basic Security Profile and SAML 2.0 for authentication.

Appendix V of [IHE ITI-TF-2] defines a set of interoperability rules and guidance to defining a request-response web services contract that is based on the DEC profile actors defined in the IHE PCD technical framework.

This contract can be expressed via the web services description language (WSDL), and is provided as an informative implementation artefact in clause 8.5. Together with the rules defined in Appendix V of [IHE ITI-TF-2], this service contract can be used to create consistent and interoperable messages which contain the core PCD-01 transaction payloads. For a sample request/response message, please see clauses 8.8 and 8.10. Figure 7-1 shows the sequence diagram for the communicate PCD data transaction.

At a minimum, a certified Continua services observation sender device must implement the device enterprise communications (DEC) device observation reporter actor and be capable of delivering PCD-01 observation result messages that conform to the data and messaging guidelines defined in the Annexes. Similarly, a certified Continua services observation receiver device must implement the DEC device observation consumer actor and conform to the services observation receiver related guidelines/constraints.

Due to the importance of controlling network traffic, it is strongly encouraged that a PHG allows for a mechanism for controlling the frequency of measurement upload.

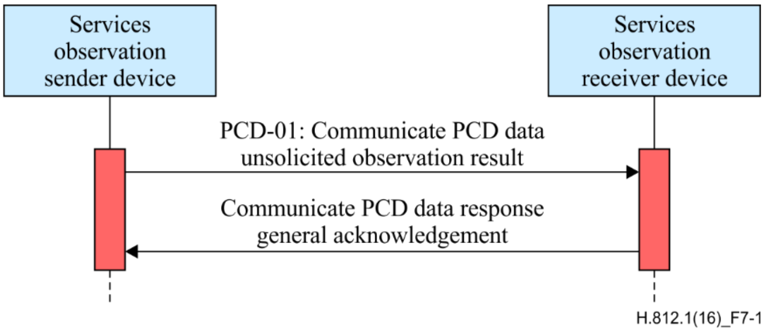


**Figure 7-1 – Communicate PCD data**

Using this web services profile as a base, it is possible to layer on additional standards such as those developed in the Organization for the Advancement of Structured Information Standards (OASIS) in order to support enhanced qualities of service, including secure and reliable communication patterns which are required and/or are beneficial in specific scenarios. In order to support these functions in a consistent manner, services observation sender and receiver devices must conform to the constraints upon these standards that are found within the WS-I Basic Security Profile (BSP) v1.0 interoperability profile and the WS-ReliableMessaging v1.1 standard. These additional concerns are covered in clauses 7.3 and 7.3.4, respectively.

## 7.2 REST implementation

### 7.2.1 Capabilities exchange

Observation Upload receivers and senders using hData are required to support capabilities exchange. For Observation Upload receivers and senders using SOAP only supporting this feature is optional. Observation Upload receivers supporting capability exchange must provide a root.xml containing its capabilities as specified in Figure 7-2. Observation Upload senders supporting capability exchange are not required to provide a root.xml though they are allowed to do so. When a root.xml is provided by an application, its capabilities are indicated in the root.xml by including xml elements as shown in Figure 7-2.

The primary purpose of the exchange is to allow PHG applications to discover what capability classes the receiver supports. The capability elements also often provide a URL 'starting point'; for example, where to POST the PCD-01 document for Observation Upload capability classes or where to POST the PHG components of the APB resource in APS establishment for APS capability classes. However, beyond this URL 'starting point', there is no further information about the capability class features provided in these capability elements. For example, what type of shoulder tap method might be supported in the APS is not present; one has to engage in APS establishment to obtain that information.

Figure 7-2 shows the capability elements for Observation Upload applications supporting hData. Note that PHG applications that choose to provide a root.xml will leave the <path> element empty as this element specifies where to POST the PCD-01 document and is only valid for receivers.

Figure 7-3 shows the capability elements for Observation Upload applications supporting an OAuth authentication server. Inclusion of these elements is optional even if the application supports an authentication server.

Figure 7-4 shows the capability elements for exposing SOAP-based Observation Uploads. Inclusion of these elements is optional even if the application supports additional device classes using hData.

Figure 7-5 shows the capability elements for applications that support a security assertion markup language (SAML) token service using WS-Trust. At this time only the Security Token Service (STS) UserName and STS X509 service types are denoted in these elements. Inclusion of these elements is optional even if the application supports additional capability classes using hData.

The presence of any of the capability elements in Figure 7-3 to Figure 7-5 is optional in all cases. The advantage of including them is that it reduces the out-of-band activity required to configure an Observation Upload client.

```
<profile>
 <!-- Specified value -->
 <id>observation-upload-hData</id>
 <reference>
  http:// handle.itu.int/11.1002/3000/hData/Upload/2016/01/H.812.1.pdf (example
URL only)
 </reference>
</profile>
<section>
 <!-- chosen by the HFS; empty on PHG -->
 <path>path/to/payload/post for hData</path>
 <profileID>observation-upload-hData</profileID>
 <resourceTypeID>observation</resourceTypeID>
</section>
<resourceType>
 <resourceTypeID>observation</resourceTypeID>
 <!-- location of reference that describes the Observation upload standard -->
 <reference>
  http://www.ihe.net/uploadedFiles/Documents/PCD/IHE_PCD_TF_Vol2.pdf
 </reference>
 <representation>
  <mediaType>application/txt</mediaType>
  <!-- Schema for the resource -->
 </representation>
<resourceType>
```

**Figure 7-2 – Capability elements for applications supporting hData Observation Uploads**

```
<profile>
 <!-- Specified value -->
 <id>oAUTH</id>
 <reference>
  http://handle.itu.int/11.1002/3000/hData/Upload/2016/01/H.812.1.pdf
 </reference>
</profile>
<section>
 <!-- chosen by the HFS; empty on PHG -->
 <path>path/to/post for oAUTH token</path>
 <profileID>oAUTH</profileID>
</section>
<resourceType>
 <resourceTypeID>oAUTH-Bearer</resourceTypeID>
 <!-- location of reference that describes the Observation upload standard -->
 <reference>
  http://tools.ietf.org/html/rfc6750
 </reference>
 <representation>
  <mediaType>application/json</mediaType>

 </representation>
<resourceType>
```

**Figure 7-3 – Capability elements for applications supporting an OAuth 2.0 authentication service**

```
<profile>
 <!-- Specified value -->
 <id>observation-upload-SOAP</id>
 <reference>
  http://handle.itu.int/11.1002/3000/hData/Upload/2016/01/H.812.1.pdf
</reference>
</profile>
<section>
 <!-- chosen by the HFS; empty on PHG -->
 <path>path/to/CommunicatePCDData</path>
 <profileID>observation-upload-SOAP</profileID>
</section>
```

**Figure 7-4 – Capability elements for applications supporting SOAP Observation Uploads**

```
<profile>
 <!-- Specified value -->
 <id>STS-Username/STS-X509</id>
 <reference>
  http://handle.itu.int/11.1002/3000/hData/Upload/2016/01/H.812.1.pdf
</reference>
</profile>
<section>
 <!-- chosen by the HFS; empty on PHG -->
 <path>path/to/STS-Username or STS-X509 service</path>
 <profileID>STS-Username/STS-X509</profileID>
</section>
```

**Figure 7-5 – Capability elements for applications supporting WS-Trust SAML token service**

The capability exchange involves the observation sender device invoking a REST GET transaction to a resource location specified by the capability exchange specification [ITU-T H.812.3]. The transaction requires a minimum server certificate validation on the client side TLS but requires no authentication token. The response contains the root.xml of the observation receiver. The observation sender may, if it so desires, invoke a REST POST transaction to the same URL as the GET of the server's root.xml. In this case the transaction does require an authentication token. The server returns a resource locator where the observation sender can access the POSTed document or a code indicating that the transaction is not supported.

Even SOAP-only observation senders can benefit from this transaction by providing the URLs to the respective SOAP service resources so that the only out-of-band action necessary for client configuration is entry of the base URL.

### 7.2.2 Observation Upload using hData

Observation Upload using hData, as shown in Figure 7-6, uses the hData framework standard [HL7 V3 HRF] coupled with the hData REST transport binding standard [OMG/hData RESTful Trans]. These two documents in turn rely on HTTPS and the Internet Standard HTTP and TCP/IP protocol stacks. Observation Upload using REST requires implementation of the hData Content Profile Document for Observation Upload (https://hdata.continuaalliance.org/hdata/consumer), which contains narrative text and an XML schema, that defines the specific encoding of the mandatory and optional elements of the hData framework that are to be used for Observation Upload.

The REST interface is intended to support a range of use cases from informal health, wellness, fitness and social engagement applications to simple clinical applications. The REST style of HTTP(S) web services interface is prevalent in consumer Internet applications, such as those routinely found on smartphone and tablet platforms such as iOS and Android. REST web services are increasingly being used in the healthcare domain, as several projects in HL7 (Health Level 7 International, 2013) and IHE (Integrating the Healthcare Enterprise, 2013) demonstrate.

The RESTful resource-oriented model for web services is very simple. Every resource is labelled by a distinct URI and all resources are operated upon by the basic HTTP verbs, GET, POST, PUT, DELETE, etc. The content of the resources are carried in the body of an HTTP message, perhaps URL-encoded for "safe passage" through the Internet. Basic security is provided by using TLS encryption (HTTPS) and authentication is provided by the inclusion of the HTTP Authorize header in each message.

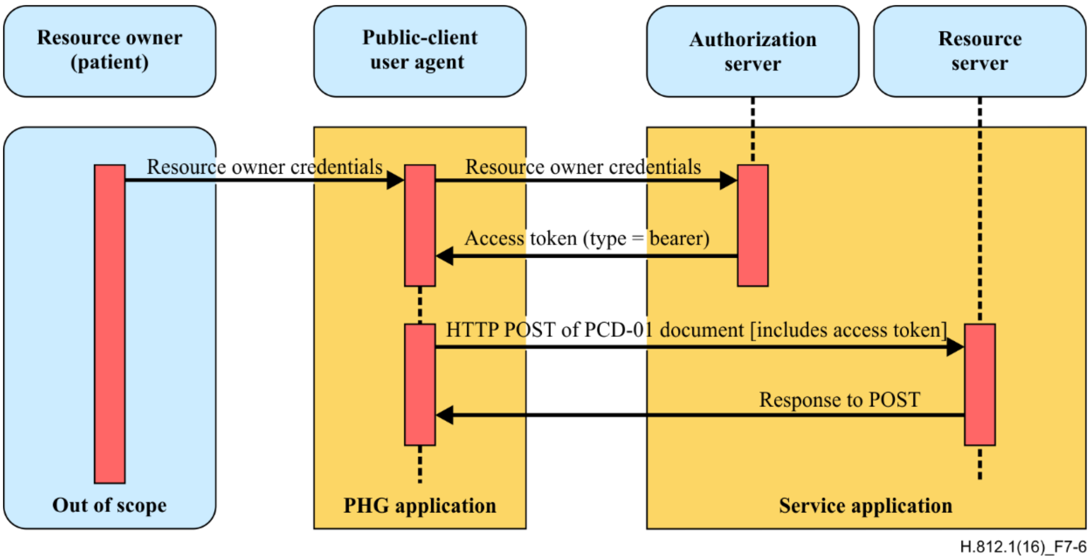


**Figure 7-6 – hData Observation Upload**

The RESTful interface is intended to be light weight in terms of its on-the-wire encoding and low-footprint in terms of the incremental software libraries that would need to be included above and beyond those included in the base SDK of common host platform operating systems. Specific emphasis is given to modern mobile platforms, such as smartphones, but desktop, laptop and embedded systems benefit equally from this simple design concept.

The REST interface is intended to be modular and to be used by multiple Continua Certified Capability Classes. For feature parity with the Services interface as defined in clause 7.1, the REST interface defines one application layer "user" of its services, the Consumer Vitals Upload Use Case.

## 7.3 Security

The Continua Services security guidelines are based on the following concepts, originally defined in [b-ISO 27000]:

– **Confidentiality**: "property that information is not available or disclosed to unauthorized individuals, entities or processes (set of interrelated or interacting activities which transform inputs into outputs)".

– **Integrity**: "property of protecting the accuracy and completeness of the assets (Assets-anything that has value to the organization. Assets can be various types including: i) information, ii) software such as computer programs, iii) physical such as computer, iv) services)."

– **Availability**: "property of being accessible and usable upon demand by an authorized entity."

– **Accountability**: "responsibility of an entity for its actions and decisions."

– **Authentication**: "provision of assurance that the claim characteristic of an entity is correct."

– **Authorization**: "only fully identified and authenticated entities, equipped with access control credentials, should be able to avail themselves of services provided by systems."

– **Access control**: "means that access to assets is authorized and restricted based on business and security requirements."

### 7.3.1 Secure point-to-point communication

The secured point-to-point communication will ensure the confidentiality and integrity of the data over the Services-IF. The scope of these guidelines is limited to a session oriented, synchronous and point-to-point communication channel between the Services observation sender device and the Services observation receiver device. Furthermore, the Services observation receiver device is assumed to be a fully trusted device, having full control over the data after reception from the TLS channel. The focus of the guidelines is to provide a secure communication channel through which data can be transmitted and not on the message level security.

The tools used to provide secure communication are selected from the WS-I (Web Services Interoperability) Basic Security Profile (BSP) – TLS v1.0. The Continua guidelines utilize the same set of mechanisms from WS-I BSP for node authentication and secure communication as that of the Integrating the Healthcare Enterprise audit trail and node authentication (IHE ATNA) IT infrastructure profile.

However, unlike audit trail and node authentication (ATNA) which requires mutual TLS authentication, the Continua guidelines do not provide additional guidance regarding the use of TLS v1.0 and instead depend on the guidance that is provided in TLS v1.0. The use of mutual or client-authenticates-server-only TLS is left up to the application.

Figure 7-7 provides an overview of the interactions between the services observation sender device and the services observation receiver device in the context of secured communication in order to provide a basic level of confidentiality and integrity. Though the figure indicates the case of mutual TLS authentication, the services observation receiver device is not required to perform this additional step of authenticating the observation sender device.

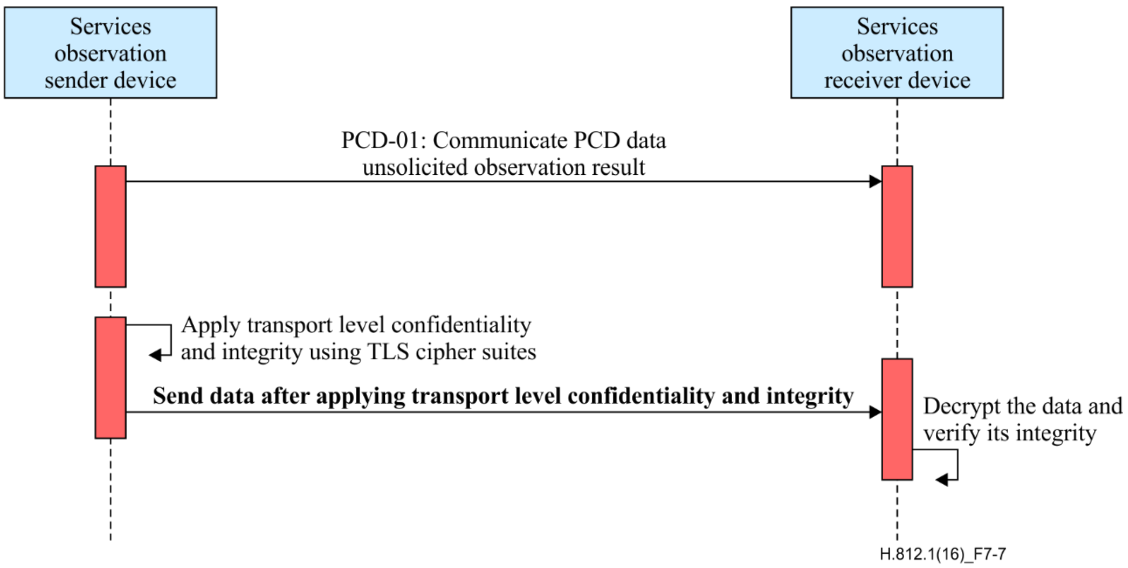


**Figure 7-7 – Secure point-to-point communication sequence**

After the successful authentication, mutual or otherwise, transport level data confidentiality and integrity is applied on the transmission between the services observation sender device and services observation receiver device.

The use of TLS applies to hData transactions, as well as SOAP.

### 7.3.2 Auditing

Auditing provides a level of assurance to the healthcare providers so that they can determine an appropriate level of trust for the personal health information based upon the origin of that data. A lower level of data origin authentication can be provided through the combination of audit logs and transport level data integrity controls. This set of actions is the option that is specified in the guidelines. The guidelines allow for the use the IHE ATNA auditing related clauses (clause 3.20, ITI-TF-2) for this purpose. The services observation sender device may implement the audit record source actor and may support record audit event transaction as specified by the IHE ATNA profile. The services observation receiver device may implement the audit record repository actor as specified by IHE ATNA.

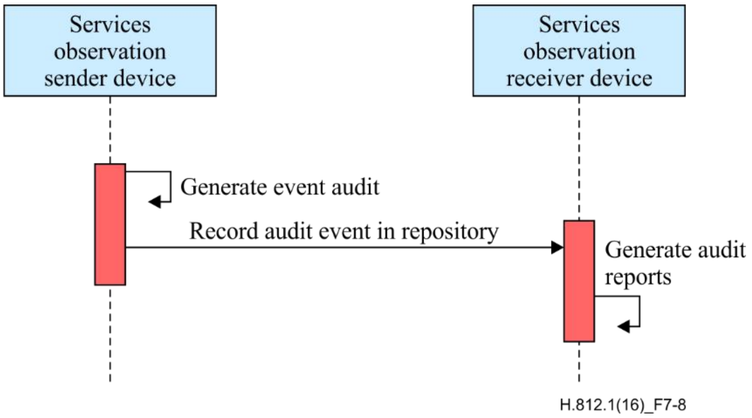


Figure 7-8 shows the interactions related to the audit records. Note that it is also possible for other system nodes to implement the audit record repository actor, but that such systems are beyond the scope of the CDG.

An alternative/complementary method of data origin authentication is to provide non-repudiation of origin. The proper use of digital signatures would provide proof of integrity and origin of the data in an unmutable and persistent fashion so that it can be verified by an independent party. In this way, use of digital signatures provides a high level of assurance to a healthcare provider that the data is coming from a particular origin and allows them to put a greater degree of trust on its reliability. Although digital signature infrastructure is beyond the scope of the current services guidelines, it is expected that this mechanism will be investigated in future releases of the CDG.

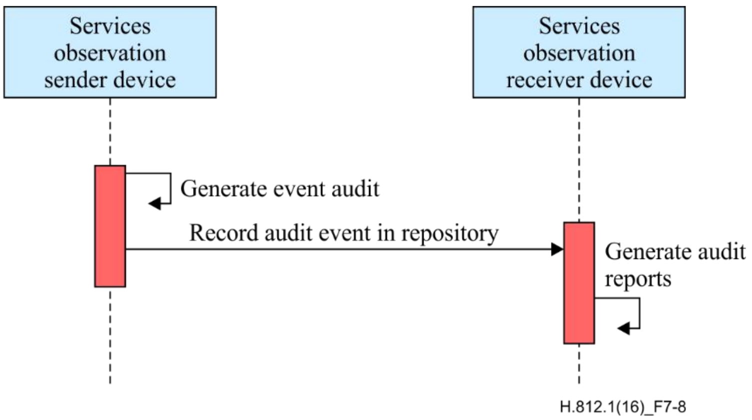


**Figure 7-8 – Auditing sequence**

### 7.3.3 Entity identity assertion

Entity identity assertion provides the necessary mechanisms that will enable the services interface to communicate claims about an entity (a person or application) who wants to connect to one of the services on the services observation receiver device. In order to allow a user to connect from the services observation sender device to a service on the services observation receiver device, there is a need to correctly identify the entity. This enables the service provider to make access control decision and audit the information for the purpose of accountability. An example scenario would be that a user wants to log in and connect to a hypertension service on the services observation receiver device, hence the hypertension service needs to identify and validate the claims of the identity provided by the user before granting them access, and will audit the relevant information such as the identity of the requested user.

Without the loss of generality, there could be two main use cases based on the installation of services observation sender device application program, i.e.:

1. A single service provider provisions an embedded box with embedded services observation sender device application and assertion information (e.g., certificate) which should authenticate and communicate to the service provider's back end (services observation receiver device). This is a static scenario.

2. A consumer installs a certified services observation sender device application on their mobile phone or PC. The services observation sender device program has the capability to send information to multiple back-end ends (services observation receiver devices). During the connection with a service on the services observation device, the services observation sender device application presents its certificate to the particular service in order to grant access to service. This is a more dynamic scenario.

In order to cover both scenarios, these guidelines mandate the support of SAML 2.0 assertions in SOAP uploads and OAuth access tokens in hData uploads. Since SAML is only used in Observation Uploads, it is discussed in this document. OAuth is used in several hData-based capabilities so it is discussed in the common security guidelines clauses in [ITU-T H.812].

#### 7.3.3.1 SOAP transactions: SAML 2.0

The specification for the use of SAML in these guidelines is similar to the IHE cross enterprise user assertion (XUA) profile. The IHE XUA profile uses the WS-Security header only with the SAML 2.0 assertions. However, the IHE XUA profile allows the use of the other type of tokens in order to provide identity information such as user name token, with the condition that interoperability has been assured through a policy between the communication parties. In a similar fashion, the Continua design guidelines constrain the WS-Security profile from WS-I BSP by using only the WS-Security header with the SAML 2.0 assertion as a security token and allow the use of any other token for providing the identity information, with the condition that interoperability is assured through policy. In other words, a Continua certified services Observation Upload receiver using SOAP is required to support SAML 2.0 assertions, but is allowed to use other means of identity authentication. The mechanism through which a specific token is obtained is beyond the scope of the CDG. A user could obtain such a token through WS-Trust, SAML 2.0 core protocols, or any other out-of-band mechanisms.

Figure 7-9 shows interactions related to entity assertion on the Services-IF. The full line shows the transaction in the scope of the Continua guidelines while the dotted lines show the transactions that are out of scope of the Continua guidelines.

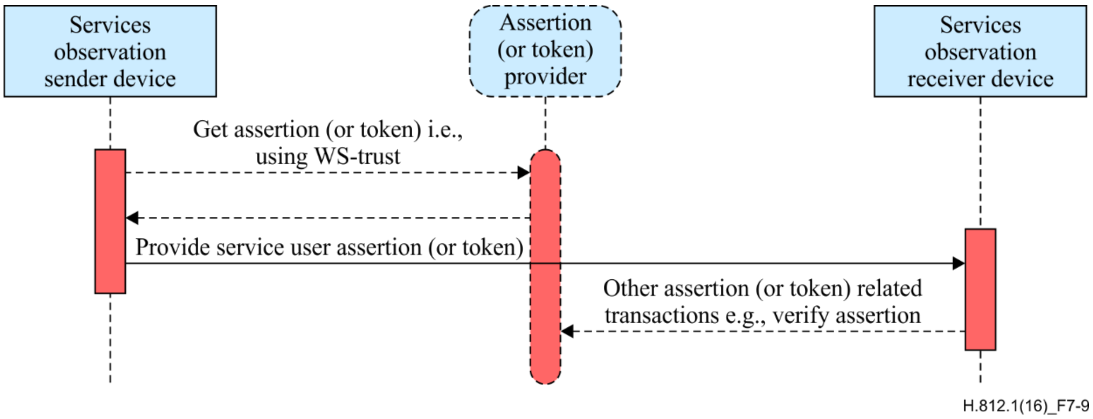


**Figure 7-9 – Entity identity assertion sequence**

### 7.3.4 Reliability

#### 7.3.4.1 SOAP transactions: WS-Reliable messaging

While the Continua services interface makes use of HTTP over the reliable TCP/IP protocol, message-level delivery cannot be guaranteed due to software component, system and network failures. These failures may be especially common for specific PHG platforms which operate over an intermittent connection such as portable laptops and mobile phones. Even with the use of HTTP response codes, it can be difficult to deal with these failures in a reliable and consistent manner. For instance, if an observation request is sent from the PHG and the connection is terminated before a response code is received, the PHG has no way of knowing whether:

1. the connection was terminated before the services observation receiver device has received the request, or
2. the services observation receiver device has received the request and generated a response which was lost due to network failure.

For non-critical data, such as the information classified in the "better" reliability category by the Continua end-to-end system architecture quality of service strategy (clause 6 of [ITU-T H.810]), this unknown state may be acceptable to an PHG, meaning that the PHG can safely remove this data from memory.

However, for critical data such as the information classified in the "best" reliability category, an PHG must ensure that the data is delivered successfully. In order to address both situations in the 'best' case, the PHG must "replay" the request to the services observation receiver device in case the data did not get delivered (case 1) but in such a manner that it is possible to detect and remove duplicate messages in the case where the data did get delivered but the sender did not get notified of the delivery (case 2).

This issue of reliable message delivery can be handled at multiple levels and has been built into the HL7 v2 application protocol messaging standard through the use of unique message identifiers and, optionally a sequence identifier in the message header (MSH) segment. However, handling message delivery at the application level has a number of disadvantages.

For instance, consider a services observation receiver device which has received a CommunicatePCDData request. The receiving device must process the observation result message and take some action, such as forwarding it to another system or persisting it in a database. If this action is lengthy/involved, perhaps due to transactional properties of the system, an acknowledgement of the initial transmission is not sent to the services observation sender device until the application-level response for the request is available. This delay can lead to scaling issues on the services observation receiver device due to the holding of resources associated with each connection. The delay might also lead to confusion on the services observation sender device due to an unacknowledged request that is still being processed. This situation can result in unnecessary "replay" messages from the services observation sender device which increases network traffic.

It is these issues that the OASIS Web Services Reliable Exchange (WS-RX) technical committee addresses along with the WS-ReliableMessaging (WS-RM) and WS-MakeConnection (WS-MC) standards.

Using WS-RM (see Figure 7-10), a PHG may create one or more "sequences" with the services observation receiver device. For instance, a PHG which supported WS-RM and WS-MC might establish a sequence with the "Exactly Once" message delivery to deliver messages that fall into the "best" reliability category in the end-to-end architecture, such as a large set of batched measurements.

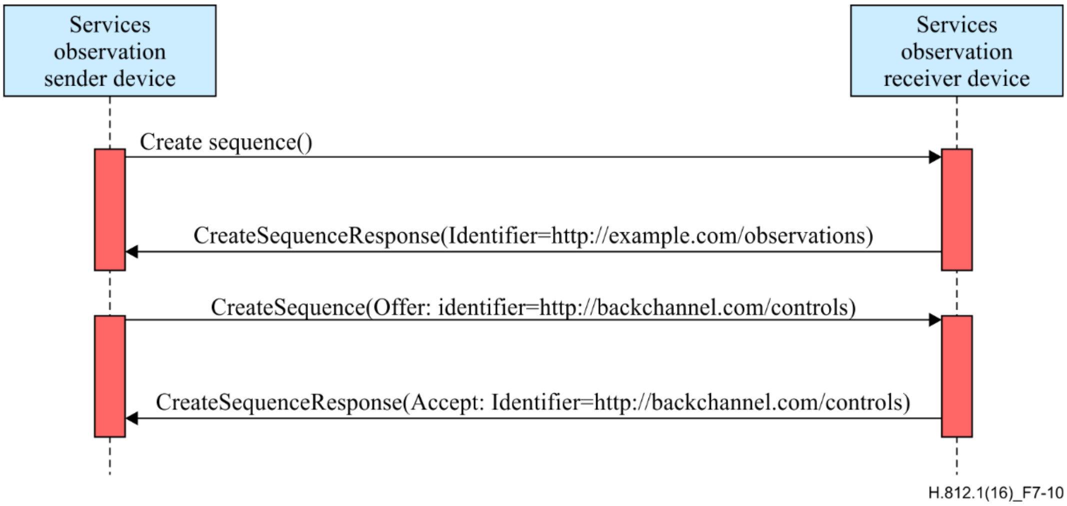


**Figure 7-10 – WS-RM sequence creation**

Using WS-RM policy, it is possible to negotiate a desired QoS for a given exchange, although this capability is beyond the profiling of this version of the services guidelines. In addition to the benefits of declaring quality of service (QoS) properties through policy and the ability to push retry logic into the exchange framework (and out of the application), using WS-RM provides clients with an optimized transport acknowledgement mechanism that can be used to support demanding workflows. When coupled with WS-MakeConnection, the services observation sender device is able to invoke the Communicate PCD Data operation using fire and forget semantics without the risk of unknowingly losing messages.

Another benefit of the WS-ReliableMessaging standard is that it allows for the explicit creation and tear-down of message sequences. For instance, in some cases, it is useful to know when a system across the services interface is going down for maintenance. These cases are difficult to handle cleanly using traditional web-oriented approaches like HTTP, because a services observation sender device would not know when a service would be unavailable and vice versa. By explicitly closing an RM sequence, a sender or receiver can indicate that they have completed the current sequence and report the final statistics of that session before going down for a planned outage. For instance, if a services observation sender device is able to close an RM sequence before going offline, this would allow an associated services observation receiver device to free any resources related to this sequence, so that it is not left waiting for the next message in the sequence to arrive.

It is important to note, however, that even with the use of the WS-Reliable messaging standard, there is no guarantee of message delivery, only that message delivery will be confirmed or not within a bounded sequence, meaning it is up to the application to set reasonable connection and sequence time-out values.

#### 7.3.4.2 hData transactions

At this time there is no equivalent of WS-Reliable messaging for hData transactions.

# 8 Implementation guidance (informative)

## 8.1 PHG conceptual model

In the following clauses a conceptual model of a PHG is presented. The model does not define normative behaviour, and the components described are not required to exist in an actual implementation. The model is presented to elucidate how a services interface could be constructed for a PHG, and to show how the services interface behaves in the context of an overall system.

The PHG presented here operates on both the Continua personal health device and services interfaces. The details of the provisioning and configuration of this device are beyond the scope of this release of the guidelines.

## 8.2 Overview of operation

A Continua PHG collects observations from personal health devices that the PHG is configured to operate with and delivers these observations to services observation receivers.

To perform this operation the PHG must have sufficient knowledge about the information being reported by a device to be able to construct an observation that can be correctly understood when delivered in the context of a single HL7 v2.6 message.

The process is initiated by a device connecting to the PHG using the personal health interfaces. The device delivers information to the PHG in a form defined by the personal health device protocols, typically as changes in values of attributes that are identified by ISO/IEEE 11073-10101 nomenclature. The PHG uses the delivered change information, in conjunction with additional context information about the entity that it is communicating with, to construct an observation in the form of an HL7 V2.6 message as constrained by the IHE PCD-01 transaction. The additional context information is obtained from mechanisms outside the scope of this specification. An example of such a mechanism is a user who configures the PHG with the URI of a health service that supports the Services-IF.

The PHG determines the context of the arriving observation, again from externally provided information that is available to the PHG. This information must ensure that the observation taken is associated with the right person, and comes from a known, properly configured device.

The PHG takes ownership of the observation and determines the destination of the observation, as well as the security context that will be used to deliver the data.

When the PHG is able to establish a connection to the services observation receiver device, it opens a secure connection and delivers the observations maintained in the corresponding persistent session queue.

When a PHG communicates an unsolicited observation result message to the health and fitness service, it must wait for confirmation that the transmission has been successful (transport acknowledgement) and that the message was successfully processed on the server (application acknowledgement). When a PHG obtains a transport-level acknowledgement in the form of an HTTP response or WS-ReliableMessaging SequenceAcknowledgement, it can be assured that the message has been received at the services observation receiver device and can safely remove the message from its queue. However, a transport-level acknowledgement does not necessarily indicate that the message has been properly processed. For instance, it is possible that the message was received at the services observation receiver device but was rejected by the application itself. For this purpose, an HL7 application accept-response provides a confirmation that the receiving application has accepted responsibility for this event so that the PHG application may safely remove the data from memory. Similarly, if the PHG receives an application reject or application error response, it may take some form of corrective action such as attempting again later, sending the request to a separate endpoint, or alerting the user.

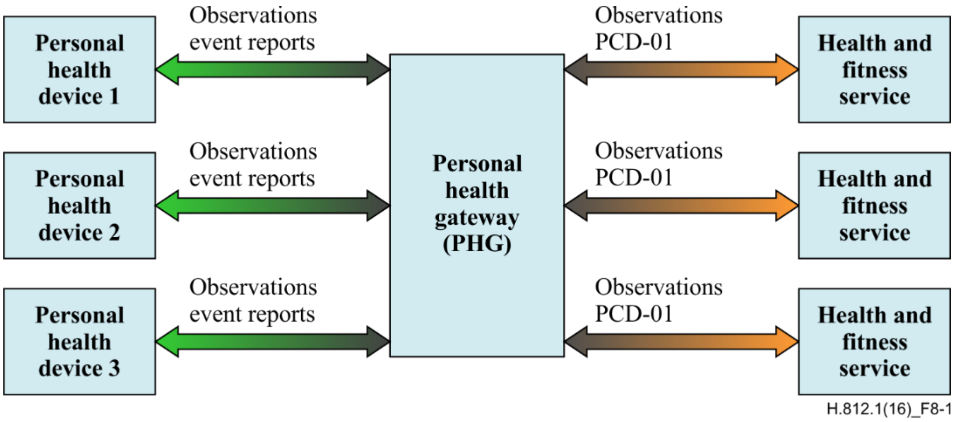


**Figure 8-1 – PHG block diagram**

The system block diagram, shown in Figure 8-1, depicts the overall flow of observations from PAN devices to Health and Fitness Services.

The PHG may collect observations from multiple PAN devices at any given point in time and a single PAN device may deliver data to multiple persistent sessions. Likewise, an PHG may deliver these observations to zero or more Health and Fitness Services.

## 8.3 Certified Capability Classes for Observation Upload

Table 8-1 shows the Certified Capability Classes defined for the Services-IF interface design guidelines for Observation Upload.

**Table 8-1 – Certified Capability Classes**

| Capability class | Continua certified |
|---|---|
| SOAP Observation Upload – PHG | Yes |
| SOAP Observation Upload – Services | Yes |
| hData Observation Upload – PHG | Yes |
| hData Observation Upload – Services | Yes |

The guidelines that are applicable for each of the Certified Capability Classes are referenced in Table 8-2.

**Table 8-2 – Guidelines for Certified Capability Classes**

| Certified Capability Class | Relevant guidelines |
|---|---|
| SOAP Observation Upload – PHG | Table A.1, Table A.2, Table C.1, Table C.2<br>PCD-01 Payload: Annex D |
| SOAP Observation Upload – Services | Table A.1, Table A.3, Table C.1, Table C.3 |
| hData Observation Upload – PHG | Table A.1, Table A.2, Table B.1<br>PCD-01 Payload: Annex D |
| hData Observation Upload – Services | Table A.1, Table A.3, Table B.2 |

Identities of patients play a key role in this architecture. The context of most communication is related to a specific patient. Throughout the architecture different identifiers are used to identify the same physical user (patient) in addition to the use of different representations for identities and other identity information.

Regulations and good practices mandate an accurate and reliable linking of health information to a patient identity. As a consequence, the various devices that are part of the architecture must be properly provisioned with identity information such as identifiers and associated credentials, identify the user, and map identities correctly when health information moves from one realm to another.

By definition identifiers are only well-defined in the realm they belong to. This corresponds for the various devices/Servicesto:

– UserID @Personal Health Devices: IEEE 11073 Person-Id + System-Id pair

– UserID @ Services: as defined by the Services service, relates to PIDs in HL7 messages

– UserID @ HIS: as defined by the HIS service (see [ITU-T H.813] clauses 6.1.1.2, Chosen standards and profiles and 6.1.1.3, Topology.

One must also recognize that some personal health devices have no Person-Id and some other means must be used to map the device observations to a given person.

For each of the identities a user holds at the various devices and services, the user must be able to uniquely identify and (for certain interfaces) be authenticated, mappings between his identifiers must be established, and these mappings must be applied to forward exchanges across interfaces. Conceptually, the mappings may be regarded as pairwise mappings held by the PHG and Health and Fitness Service in a mapping table. This mapping assures a consistent end-to-end identity framework is created.

Figure 8-2 presents the identity related interactions between the various actors in the architecture. Below each actor the primary identifier of the user at that actor is listed. The interactions are:

1. Given the set of personal health and services identities, mappings are established and maintained in a PHG mapping table. This mapping is especially needed when there is no non-ambiguous one-to-one mapping. These mappings are managed out-of-band. The management may involve the user, or a services service employee may act as a user's delegate, e.g., a nurse at a disease management organization (DMO). In a typical scenario, it involves associating a certain personal health device with a certain user identity at a services service, e.g., patient 1 linking his weight measurements to DMO 1 and patient 2 linking his activity measurements to DMO 2.

2. Identifiers are mapped from the personal health devices interface to the Services-IF according to the PHG mapping table. Also, as part of this step any potential ambiguity, e.g., caused by shared personal health devices lacking proper user identification is taken care of. Using the mapping table the PHG populates the PID segment of the PCD-01 message based upon the information received from the personal health device.

3. Given the set of services and HIS identities, mappings are established and maintained in a services mapping table. IHE PIX transactions may be used for this process where an HIS sender queries for the patient identifier to use for a given patient at an HIS receiver. Alternatively, identities at the HIS-IF are managed out-of-band. A web-centric environment could, for example, apply identify federation protocols.

4. Identifiers are mapped from the Services-IF to the HIS-IF according to the services mapping table.

The interactions span the full range of deployments. Specific deployments use a subset of the offered functionality tailored to the situation, e.g., self, delegated or out-of-band configuration. The PHG mainly concerns step 2.

The approach is consistent with and meets the requirements identified in [b-CHA UI] on user identification.

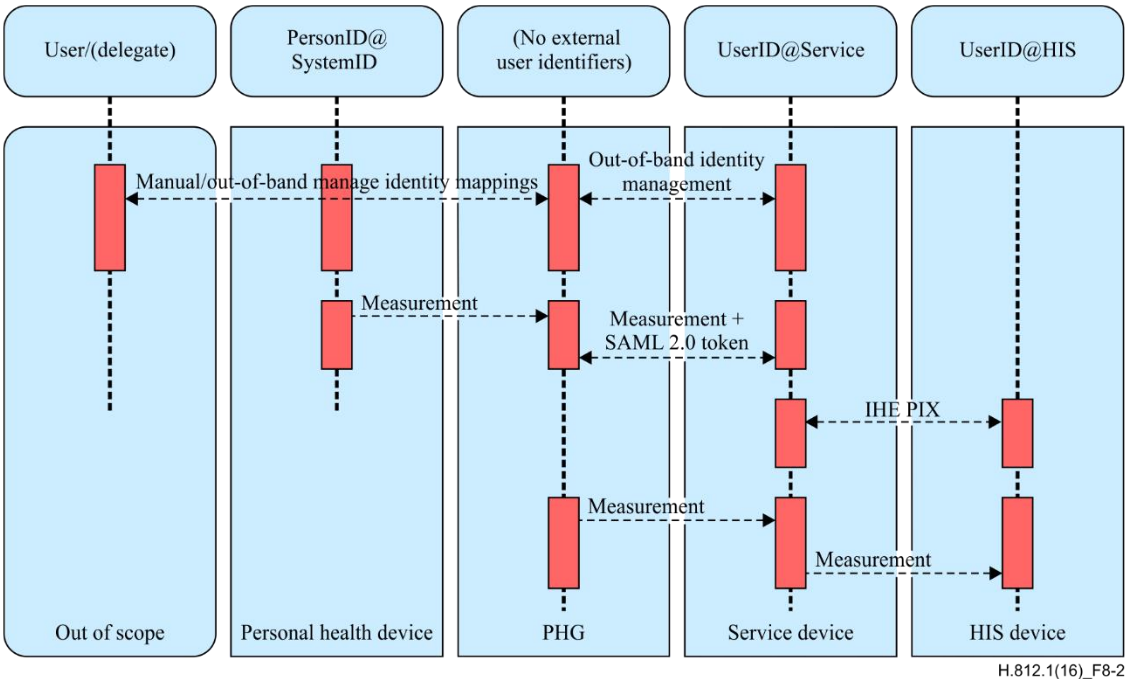


**Figure 8-2 – Identification and identity cross-referencing interactions**

## 8.4 Sample service description SOAP

The Continua services Observation Upload over SOAP interface makes use of the IHE PCD-01: Communicate PCD Data transaction over web services. Web services description language (WSDL) is a W3C standard designed to define a web service through endpoints and operations.

Appendix V of [IHE ITI-TF-2] provides guidance on deriving WSDL files from an IHE transaction. The following artefacts are provided as informative implementation artefacts and should match the versions found in the IHE [ftp://ftp.ihe.net/TF_Implementation_Material/](ftp://ftp.ihe.net/TF_Implementation_Material/) for PCD.

## 8.5 Device observation consumer WSDL

```
<?xml version="1.0" encoding="UTF-8"?>
<wsdl:definitions name="DeviceObservationConsumer"
     targetNamespace="urn:ihe:pcd:dec:2010"
     xmlns:soap12="http://schemas.xmlsoap.org/wsdl/soap12/"
     xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/"
     xmlns:xsd="http://www.w3.org/2001/XMLSchema"
     xmlns:wsaw="http://www.w3.org/2006/05/addressing/wsdl"
     xmlns:tns="urn:ihe:pcd:dec:2010">
     <wsdl:types>
          <xsd:schema>
               <xsd:import namespace="urn:ihe:pcd:dec:2010"
schemaLocation="DeviceObservationConsumer.xsd"></xsd:import>
          </xsd:schema>
     </wsdl:types>
     <wsdl:message name="CommunicatePCDData_Message">
          <wsdl:documentation>Communicate PCD Data</wsdl:documentation>
          <wsdl:part name="body" element="tns:CommunicatePCDData" />
     </wsdl:message>
     <wsdl:message name="CommunicatePCDDataResponse_Message">
          <wsdl:documentation>Communicate PCD Data Response</wsdl:documentation>
          <wsdl:part name="body" element="tns:CommunicatePCDDataResponse" />
     </wsdl:message>
     <wsdl:portType name="DeviceObservationConsumer_PortType">
```

```
			<wsdl:operation name="CommunicatePCDData">
				<wsdl:input message="tns:CommunicatePCDData_Message"
					wsaw:Action="urn:ihe:pcd:2010:CommunicatePCDData" />
				<wsdl:output message="tns:CommunicatePCDDataResponse_Message"
					wsaw:Action="urn:ihe:pcd:2010:CommunicatePCDDataResponse" />
			</wsdl:operation>
		</wsdl:portType>
		<wsdl:binding name="DeviceObservationConsumer_Binding_Soap12"
type="tns:DeviceObservationConsumer_PortType">
			<soap12:binding style="document"
				transport="http://schemas.xmlsoap.org/soap/http" />
			<wsdl:operation name="CommunicatePCDData">
				<soap12:operation soapAction="urn:ihe:pcd:2010:CommunicatePCDData"
/>
				<wsdl:input>
					<soap12:body use="literal" />
				</wsdl:input>
				<wsdl:output>
					<soap12:body use="literal" />
				</wsdl:output>
			</wsdl:operation>
		</wsdl:binding>
		<wsdl:service name="DeviceObservationConsumer_Service">
			<wsdl:port binding="tns:DeviceObservationConsumer_Binding_Soap12"
name="DeviceObservationConsumer_Port_Soap12">
				<soap12:address location="http://www.example.org/" />
			</wsdl:port>
		</wsdl:service>
</wsdl:definitions>
```

### 8.6 Device observation consumer XSD

```
<?xml version="1.0" encoding="UTF-8"?>
<schema xmlns="http://www.w3.org/2001/XMLSchema"
targetNamespace="urn:ihe:pcd:dec:2010" xmlns:tns="urn:ihe:pcd:dec:2010">
	<element name="CommunicatePCDData" type="tns:UnsolicitedObservationResult"
/>
	<element name="CommunicatePCDDataResponse"
type="tns:GeneralAcknowledgement" />

	<simpleType name="UnsolicitedObservationResult">
		<restriction base="string" />
	</simpleType>

	<simpleType name="GeneralAcknowledgement">
		<restriction base="string" />
	</simpleType>
</schema>
```

### 8.7 Messaging examples

In addition to the WSDL-related rules found in Appendix V of [IHE ITI-TF-2], the framework contains a number of conformance constraints for web service consumers and providers. These rules were developed to improve IHE-related web service interoperability and Continua services observation senders and receivers are required to comply.

Note that the contents of the urn:ihe:pcd:dec:2010:CommunicatePCDData element must contain the entire contents of a valid PCD-01 Observation Result message. However, based on the character restrictions of XML and web services, there are a number of characters that cannot be used in their literal form (see http://www.w3.org/International/questions/qa-controls#support for more information).

Restricted characters, such as "&" and "<cr>", must be escaped using XML predefined character entity references wherever possible (e.g., &). For restricted characters that have no predefined character entity references, numeric character references should be used instead (e.g., &#d;). Messages containing characters which are prohibited from use in XML in both a literal and escaped format are prohibited from being sent over the Continua services interface.

For a complete list of excluded characters, please see the XML specification at http://www.w3.org/TR/xml/#syntax.

The following informative clauses contain a sample CommunicatePCDData message and a typical response. Note that the message is unsecure and would not occur in operations.

### 8.8 Communicate PCD data

```
<soapenv:Envelope xmlns:soapenv="http://www.w3.org/2003/05/soap-envelope">
     <soapenv:Header xmlns:wsa="http://www.w3.org/2005/08/addressing">
          <wsa:To soapenv:mustUnderstand="true">
http://localhost/DeviceObservationConsumer_Service
          </wsa:To>
          <wsa:From soapenv:mustUnderstand="true">
               <wsa:Address>
http://www.w3.org/2005/08/addressing/anonymous
</wsa:Address>
          </wsa:From>
          <wsa:MessageID soapenv:mustUnderstand="true">
               urn:uuid:A52590343911955D1A1251497585530
</wsa:MessageID>
          <wsa:Action soapenv:mustUnderstand="true">
               urn:ihe:pcd:2010:CommunicatePCDData
</wsa:Action>
     </soapenv:Header>
     <soapenv:Body>
          <CommunicatePCDData xmlns="urn:ihe:pcd:dec:2010">
MSH|^~\&|AcmeInc^ACDE48234567ABCD^EUI-
64||||20090713090030+0000||ORU^R01^ORU_R01|MSGID1234|P|2.6|||NE|AL|||||IHE PCD ORU-R01
2006^HL7^2.16.840.1.113883.9.n.m^HL7
PID|||789567^^^Imaginary Hospital^PI ||Doe^John^Joseph^^^^L^A|||M
OBR|1|AB12345^AcmePHGInc^ACDE48234567ABCD^EUI-64|CD12345^AcmePHGInc^ACDE48234567ABCD^EUI-
64|182777000^monitoring of patient^SNOMED-CT|||20090813095715+0000
PHG-OBXes
OBX|n|CWE|68220^MDC_TIME_SYNC_PROTOCOL^MDC|0.0.0.y|532224^MDC_TIME_SYNC_NONE^MDC|||||R
OBX|n+1||528391^MDC_DEV_SPEC_PROFILE_BP^MDC|1|||||||X|||||||0123456789ABCDEF^^0123456789ABCDEF^EUI-
64
OBX|n+2|DTM|67975^MDC_ATTR_TIME_ABS^MDC|1.0.0.x|20091028123702||||||R|||20091028173702+0000
More MDS-OBXes
OBX|m||150020^MDC_PRESS_BLD_NONINV^MDC|1.0.1|||||||X|||20090813095715+0000
OBX|m+1|NM|150021^MDC_PRESS_BLD_NONINV_SYS^MDC|1.0.1.1|120|266016^MDC_DIM_MMHG^MDC|||||R
OBX|m+2|NM|150022^MDC_PRESS_BLD_NONINV_DIA^MDC|1.0.1.2|80|266016^MDC_DIM_MMHG^MDC|||||R
OBX|m+3|NM|150023^MDC_PRESS_BLD_NONINV_MEAN^MDC|1.0.1.3|100|266016^MDC_DIM_MMHG^MDC|||||R
          </CommunicatePCDData>
     </soapenv:Body>
</soapenv:Envelope>
```

The implementer should note that one source of confusion has been in the difference between the urn:ihe:pcd:2010 qualifier in the wsa:Action value and the urn:ihe:pcd:dec:2010 qualifier in the CommunicatePCDData element attribute. They are not the same.

### 8.9 Communicate PCD data response

```
<?xml version="1.0" encoding="UTF-8"?>
<soapenv:Envelope xmlns:soapenv="http://www.w3.org/2003/05/soap-envelope">
     <soapenv:Header xmlns:wsa="http://www.w3.org/2005/08/addressing">
          <wsa:Action soapenv:mustUnderstand="true">
urn:ihe:pcd:2010:CommunicatePCDDataResponse
          </wsa:Action>
          <wsa:RelatesTo soapenv:mustUnderstand="true">
urn:uuid:A52590343911955D1A1251497585530
```

```
			</wsa:RelatesTo>
		</soapenv:Header>
		<soapenv:Body>
			<CommunicatePCDDataResponse xmlns="urn:ihe:pcd:dec:2010">
MSH|^~\&amp;|Stepstone||AcmeInc^ACDE48234567ABCD^EUI-
64||20090726095731+0000||ACK^R01^ACK|AMSGID1234|P|2.6|&#xD;
MSA|AA|MSGID1234&#xD;
			</CommunicatePCDDataResponse>
		</soapenv:Body>
</soapenv:Envelope>
```

In the above response the 'mustUnderstand' attributes have been added to be consistent with Appendix V of [IHE ITI-TF-2]. The WS addressing specification is not clear on the use of the 'mustUnderstand' attribute in the response for those headers which have the attribute in the request. However, the examples in the WS addressing specification do have matching attributes in the response.

### 8.10 CommunicatePCDData example with security

This example illustrates a scenario where an organization provides a services receiver service that also supports a WS-Trust STS service using the username token option for obtaining an SAML token. A client creates an account with this organization in order to access these services. The account has a user name and password which the client is to use to obtain the SAML token.

When it is time to send data over the services interface, the PHG first requests an SAML token from the organization using the Username Token STS request. The service scans the username and password in the Username Token and sees that it is a registered user. The service creates a signed SAML token identifying the client and returns it to the user. When data is to be sent, the SAML token is placed into the security header of the CommunicatePCDData transaction. The services service validates the token to see if it is an authenticated and authorized user and if valid handles the received data. In this scenario, the client has instructed the services service to translate any received data to a PHMR document and to send it to a specified repository.

NOTE – The PHMR Implementation Guide is currently undergoing significant revisions as it is transitioning from a draft Standard for trial use (DSTU) to a normative specification in HL7. As such, implementers can expect changes to the HIS interface as soon as the final normative PHMR Implementation Guide is available to be profiled, to be expected as errata to these Design Guidelines or in the next revision.'

Some liberties in the formatting of the messages in the following have been taken to make it readable.

#### 8.10.1 STS request

Below is the WS-Trust Username Token request for an SAML 2.0 token. There is an optional 'claims' element used by this particular STS-service for this transaction. The transaction is sent using TLS so on the wire the password is not legible.

```
POST /axis2/services/STS_Username HTTP/1.1
Content-Type: application/soap+xml; charset=UTF-8;
action="http://schemas.xmlsoap.org/ws/2005/02/trust/RST/Issue"
User-Agent: Dalvik/1.6.0 (Linux; U; Android 4.0.4; Nexus S Build/IMM26)
Host: 192.168.1.3:8443
Connection: Keep-Alive
Accept-Encoding: gzip
Content-Length: 2414

<?xml version='1.0' encoding='UTF-8'?>
<soapenv:Envelope xmlns:soapenv="http://www.w3.org/2003/05/soap-envelope">
 <soapenv:Header xmlns:wsa="http://www.w3.org/2005/08/addressing">
  <wsse:Security soapenv:mustUnderstand="true"
 xmlns:wsse="http://docs.oasis-open.org/wss/2004/01/oasis-200401-wss-wssecurity-secext-1.0.xsd"
 xmlns:wsu="http://docs.oasis-open.org/wss/2004/01/oasis-200401-wss-wssecurity-utility-1.0.xsd">
   <wsu:Timestamp wsu:Id="Timestamp-3">
    <wsu:Created>2013-03-01T16:54:53.797</wsu:Created>
```

```
    <wsu:Expires>2013-03-01T16:59:53.797</wsu:Expires>
   </wsu:Timestamp>

   <wsse:UsernameToken wsu:Id="UsernameToken-ID">
    <wsse:Username>Sisansarah</wsse:Username>
    <wsse:Password Type="http://docs.oasis-open.org/wss/2004/01/oasis-200401-wss-username-token-
profile-1.0#PasswordText">
      publicpassword
    </wsse:Password>
   </wsse:UsernameToken>

  </wsse:Security>
  <wsa:To soapenv:mustUnderstand="true">
    https://192.168.1.3:8443/axis2/services/STS_Username
  </wsa:To>
  <wsa:ReplyTo soapenv:mustUnderstand="true">
   <wsa:Address>http://schemas.xmlsoap.org/ws/2004/08/addressing/role/anonymous</wsa:Address>
  </wsa:ReplyTo>
  <wsa:MessageID soapenv:mustUnderstand="true">urn:uuid:0_1362156893800</wsa:MessageID>
  <wsa:Action soapenv:mustUnderstand="true">http://schemas.xmlsoap.org/ws/2005/02/trust/RST/Issue
  </wsa:Action>
 </soapenv:Header>
 <soapenv:Body>
  <wst:RequestSecurityToken xmlns:wst="http://docs.oasis-open.org/ws-sx/ws-trust/200512">
   <wst:RequestType>http://docs.oasis-open.org/ws-sx/ws-trust/200512/Issue</wst:RequestType>
   <wst:Lifetime>
    <wsu:Created xmlns:wsu="http://docs.oasis-open.org/wss/2004/01/oasis-200401-wss-wssecurity-
utility-1.0.xsd">2013-03-01T16:59:53.797</wsu:Created>
    <wsu:Expires xmlns:wsu="http://docs.oasis-open.org/wss/2004/01/oasis-200401-wss-wssecurity-
utility-1.0.xsd">2013-03-01T17:04:53.797</wsu:Expires>
   </wst:Lifetime>
   <wst:TokenType>
    http://docs.oasis-open.org/wss/oasis-wss-saml-token-profile-1.1#SAMLV2.0
   </wst:TokenType>
   <wst:KeyType>http://docs.oasis-open.org/ws-sx/ws-trust/200512/SymmetricKey</wst:KeyType>
   <wst:KeySize>256</wst:KeySize>
   <wst:Entropy>
    <wst:BinarySecret Type="http://docs.oasis-open.org/ws-sx/ws-trust/200512/Nonce">
     i369jzmWbYlMB8uEAQwXghli9iORbIRM4IQCQFICrwI=
    </wst:BinarySecret>
   </wst:Entropy>
   <wst:ComputedKeyAlgorithm>
     http://docs.oasis-open.org/ws-sx/ws-trust/200512/CK/PSHA1
   </wst:ComputedKeyAlgorithm>
   <wst:Claims Dialect="SomeURI">Continua</wst:Claims>
  </wst:RequestSecurityToken>
 </soapenv:Body>
</soapenv:Envelope>
```

### 8.10.2 STS response

The STS response contains the SAML token which the application removes and inserts into the security header of the CommunicatePCDData transaction. Recall that obtaining the SAML token is out of band as far as the Continua guidelines are concerned.

```
HTTP/1.1 200 OK
Server: Apache-Coyote/1.1
Content-Type: application/soap+xml;action="urn:RequestSecurityTokenResponse";charset=UTF-8
Transfer-Encoding: chunked
Date: Fri, 01 Mar 2013 16:54:27 GMT

<?xml version='1.0' encoding='UTF-8'?><soapenv:Envelope
xmlns:soapenv="http://www.w3.org/2003/05/soap-envelope">
 <soapenv:Header xmlns:wsa="http://www.w3.org/2005/08/addressing">
  <wsse:Security
   xmlns:wsse="http://docs.oasis-open.org/wss/2004/01/oasis-200401-wss-wssecurity-secext-1.0.xsd"
   xmlns:wsu="http://docs.oasis-open.org/wss/2004/01/oasis-200401-wss-wssecurity-utility-1.0.xsd"
     soapenv:mustUnderstand="true">
   <wsu:Timestamp wsu:Id="TS-13">
    <wsu:Created>2013-03-01T16:54:27.880Z</wsu:Created>
    <wsu:Expires>2013-03-01T16:59:27.880Z</wsu:Expires>
   </wsu:Timestamp>
  </wsse:Security>
  <wsa:Action soapenv:mustUnderstand="true">urn:RequestSecurityTokenResponse</wsa:Action>
  <wsa:RelatesTo soapenv:mustUnderstand="true">urn:uuid:0_1362156893800</wsa:RelatesTo>
 </soapenv:Header>
```

```
 <soapenv:Body>
  <wst:RequestSecurityTokenResponseCollection
     xmlns:wst="http://docs.oasis-open.org/ws-sx/ws-trust/200512">
   <wst:RequestSecurityTokenResponse>
    <wst:TokenType>
      http://docs.oasis-open.org/wss/oasis-wss-saml-token-profile-1.1#SAMLV2.0
    </wst:TokenType>
    <wst:KeySize>256</wst:KeySize>
    <wst:RequestedAttachedReference>
     <wsse:SecurityTokenReference
   xmlns:wsse="http://docs.oasis-open.org/wss/2004/01/oasis-200401-wss-wssecurity-secext-1.0.xsd">
      <wsse:Reference URI="#urn:uuid:CCD9102DB9CE2669531362156867799"
       ValueType="http://docs.oasis-open.org/wss/oasis-wss-saml-token-profile-1.1#SAMLV2.0"/>
     </wsse:SecurityTokenReference>
    </wst:RequestedAttachedReference>
    <wst:RequestedUnattachedReference>
     <wsse:SecurityTokenReference
   xmlns:wsse="http://docs.oasis-open.org/wss/2004/01/oasis-200401-wss-wssecurity-secext-1.0.xsd">
      <wsse:Reference URI="urn:uuid:CCD9102DB9CE2669531362156867799"
       ValueType="http://docs.oasis-open.org/wss/oasis-wss-saml-token-profile-1.1#SAMLV2.0" />
     </wsse:SecurityTokenReference>
    </wst:RequestedUnattachedReference>
    <wst:Lifetime>
     <wsu:Created
   xmlns:wsu="http://docs.oasis-open.org/wss/2004/01/oasis-200401-wss-wssecurity-utility-1.0.xsd">
       2013-03-01T16:54:27.792Z
     </wsu:Created>
     <wsu:Expires
   xmlns:wsu="http://docs.oasis-open.org/wss/2004/01/oasis-200401-wss-wssecurity-utility-1.0.xsd">
       2013-03-01T17:37:39.792Z
     </wsu:Expires>
    </wst:Lifetime>
    <wst:RequestedSecurityToken>

============================= Requested SAML Token
     <saml2:Assertion
       xmlns:saml2="urn:oasis:names:tc:SAML:2.0:assertion"
       xmlns:xs="http://www.w3.org/2001/XMLSchema"
       ID="urn:uuid:CCD9102DB9CE2669531362156867799"
       IssueInstant="2013-03-01T16:54:27.792Z"
       Version="2.0">
      <saml2:Issuer>LNI SAML Token Service</saml2:Issuer>
       <ds:Signature xmlns:ds="http://www.w3.org/2000/09/xmldsig#">
        <ds:SignedInfo>
         <ds:CanonicalizationMethod Algorithm="http://www.w3.org/2001/10/xml-exc-c14n#"/>
         <ds:SignatureMethod Algorithm="http://www.w3.org/2000/09/xmldsig#rsa-sha1"/>
         <ds:Reference URI="#urn:uuid:CCD9102DB9CE2669531362156867799">
          <ds:Transforms>
           <ds:Transform
              Algorithm="http://www.w3.org/2000/09/xmldsig#enveloped-signature"/>
           <ds:Transform Algorithm="http://www.w3.org/2001/10/xml-exc-c14n#">
            <ec:InclusiveNamespaces
             xmlns:ec="http://www.w3.org/2001/10/xml-exc-c14n#" PrefixList="xs"/>
           </ds:Transform>
          </ds:Transforms>
          <ds:DigestMethod Algorithm="http://www.w3.org/2000/09/xmldsig#sha1"/>
          <ds:DigestValue>hL3WFtfHoQamGfaXGbMfGS7Nn0o=</ds:DigestValue>
         </ds:Reference>
        </ds:SignedInfo>
        <ds:SignatureValue>
dldKDhBH2YIAT7hQVdAFn1dbgZtQguJKHNOTz0QtfwAAAKb8iwYZMQuv/DwlgC0cIYprGWqp+4qnpX0Jp3OY8PpQESbrTl9/MumZ
cmQYEla8Ojey116mBGPiYmpnp1lNQvwwaZBqvOTChXRj0uns13wRteQy7vx99eQeubneIgo=
        </ds:SignatureValue>
        <ds:KeyInfo>
         <ds:X509Data>
<ds:X509Certificate>MIICvjCCAiegAwIBAgIES1f+AjANBgkqhkiG9w0BAQUFADCBiTEhMB8GCSqGSIb3DQEJARYSbmFuZGFu
YUBhcGFjaGUub3JnMQswCQYDVQQGEwJMSzEQMA4GA1UECAwHV2VzdGVybjEQMA4GA1UEBwwHQ29sb21ibzEPMA0GA1UECgwGQXBh
Y2hlMRAwDgYDVQQLDAdSYW1wYXJ0MRAwDgYDVQQDDAdzZXJ2aWNlMB4XDTEwMDEyMTA3MTA1OFoXDTM1MDExNTA3MTA1OFowgYkx
ITAfBgkqhkiG9w0BCQEWEm5hbmRhbmFAYXBhY2hlLm9yZzELMAkGA1UEBhMCTEsxEDAOBgNVBAgMB1dlc3Rlcm4xEDAOBgNVBAcM
B0NvbG9tYm8xDzANBgNVBAoMBkFwYWNoZTEQMA4GA1UECwwHUmFtcGFydDEQMA4GA1UEAwwHc2VydmljZTCBnzANBgkqhkiG9w0B
AQEFAAOBjQAwgYkCgYEAlAwDwx/FRgDReNc8Xuzo7/gHejimFkseCm+7WaFZp0dGwTnEJWNwWZk4yMw/1FqWCgGHAbJBT25TAljl
eKDMUlZJPaU6PkJD8Hn94A1EstBDYA70pH3wt1moDxYbcG2QLxC1WrFM6aqR3NB92zG8T3Q9X4jxGGWPkd39IndfdDMCAwEAAaMx
MC8wHQYDVR0lBBYwFAYIKwYBBQUHAwEGCCsGAQUFBwMCMA4GA1UdDwEB/wQEAwIEsDANBgkqhkiG9w0BAQUFAAOBgQBeAOERzydv
AUNipBKOVg3FcjGTyMg3lzo7S1DFg7qTM4FZwUf2zw9XMagVLJRsaw+Asj8mqnugTpB4jBJCrCGZ7YEviXz4PnqQjuuov5rXtFIc
1Bp/PQmQt+LiZ2zln+fFxnSoHEzUsqs5zhdy/uIP0srAtBosdHxL9BJHxd7wQw==</ds:X509Certificate>
         </ds:X509Data>
        </ds:KeyInfo>
       </ds:Signature>
       <saml2:Subject>
        <saml2:SubjectConfirmation Method="urn:oasis:names:tc:SAML:2.0:cm:holder-of-key">
```

```
          <saml2:SubjectConfirmationData
            xmlns:xsi=" http://www.w3.org/2001/XMLSchema-instance"
            NotBefore="2013-03-01T16:54:27.792Z"
            NotOnOrAfter="2013-03-01T17:37:39.792Z"
            xsi:type="saml2:KeyInfoConfirmationDataType">
           <ds:KeyInfo xmlns:ds="http://www.w3.org/2000/09/xmldsig#">
            <xenc:EncryptedKey
              xmlns:xenc="http://www.w3.org/2001/04/xmlenc#"
              Id="EK-C82A2592DB5193D51C13621568677947">
             <xenc:EncryptionMethod
               Algorithm="http://www.w3.org/2001/04/xmlenc#rsa-1_5"/>
              <ds:KeyInfo>
               <wsse:SecurityTokenReference
   xmlns:wsse="http://docs.oasis-open.org/wss/2004/01/oasis-200401-wss-wssecurity-secext-1.0.xsd">
                <wsse:KeyIdentifier
   EncodingType="http://docs.oasis-open.org/wss/2004/01/oasis-200401-wss-soap-message-security-
1.0#Base64Binary"
   ValueType="http://docs.oasis-open.org/wss/oasis-wss-soap-message-security-1.1#ThumbprintSHA1">
                 EPlMdE3oRiNlo8bGg3BLR3uGWT8=
                </wsse:KeyIdentifier>
               </wsse:SecurityTokenReference>
              </ds:KeyInfo>
              <xenc:CipherData>
               <xenc:CipherValue>
JkAWwNH+FdRevF6o9zjB+FTmwxe58jYFeHQO684YNeM5zSLvKna47h/v1OowtnDf5htaBo3uEqp8xPf+IDOYjNQLHfsDHZ60EvVU
jrHKXALE5pRcFtqX93iiUE/Ke4zpVvGQjyMxer454Qo/SL98xd6v4jpDc/zKMK4iGPO+YaI=
               </xenc:CipherValue>
              </xenc:CipherData>
             </xenc:EncryptedKey>
            </ds:KeyInfo>
           </saml2:SubjectConfirmationData>
          </saml2:SubjectConfirmation>
         </saml2:Subject>
        <saml2:Conditions NotBefore="2013-03-01T16:54:27.792Z" NotOnOrAfter="2013-03-
01T17:37:39.792Z" />
        <saml2:AttributeStatement>
         <saml2:Attribute
          Name="program"
          NameFormat="urn:oasis:names:tc:SAML:2.0:attrname-format:unspecified">
         <saml2:AttributeValue
           xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
            xsi:type="xs:string">
            Continua
         </saml2:AttributeValue>
        </saml2:Attribute>
        <saml2:Attribute
          Name="user"
          NameFormat="urn:oasis:names:tc:SAML:2.0:attrname-format:unspecified">
         <saml2:AttributeValue
          xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
          xsi:type="xs:string">Sisansarah</saml2:AttributeValue>
        </saml2:Attribute>
       </saml2:AttributeStatement>
      </saml2:Assertion>
============================= End of SAML Token

    </wst:RequestedSecurityToken>
    <wst:RequestedProofToken>
     <wst:ComputedKey>
      http://docs.oasis-open.org/ws-sx/ws-trust/200512/CK/PSHA1
     </wst:ComputedKey>
    </wst:RequestedProofToken>
    <wst:Entropy>
     <wst:BinarySecret
      Type="http://docs.oasis-open.org/ws-sx/ws-trust/200512/Nonce">
      2dDQACinnpN2oNV2kFINXEqAN8SMvTQOGpZKB3IAC9c=
     </wst:BinarySecret>
    </wst:Entropy>
   </wst:RequestSecurityTokenResponse>
  </wst:RequestSecurityTokenResponseCollection>
 </soapenv:Body>
</soapenv:Envelope>
```


### 8.10.3 CommunicatePCDData request

This request is where the PCD-01 payload is sent. For brevity, the SAML token is not shown in the following request, but it is identical to the token delivered by the STS service. Even though the token identifies the user, it is opaque to the user and unmutable since it is signed. The contents are only of interest to the receiver.

```
POST /axis2/services/Exchange HTTP/1.1
Content-Type: application/soap+xml; charset=UTF-8; action="urn:ihe:pcd:2010:CommunicatePCDData"
User-Agent: Dalvik/1.6.0 (Linux; U; Android 4.0.4; Nexus S Build/IMM26)
Host: 192.168.1.3:8443
Connection: Keep-Alive
Accept-Encoding: gzip
Content-Length: 8348

<?xml version='1.0' encoding='UTF-8'?><soapenv:Envelope
xmlns:soapenv="http://www.w3.org/2003/05/soap-envelope">
 <soapenv:Header xmlns:wsa="http://www.w3.org/2005/08/addressing">
  <wsse:Security soapenv:mustUnderstand="true"
  xmlns:wsse="http://docs.oasis-open.org/wss/2004/01/oasis-200401-wss-wssecurity-secext-1.0.xsd"
  xmlns:wsu="http://docs.oasis-open.org/wss/2004/01/oasis-200401-wss-wssecurity-utility-1.0.xsd">
   <wsu:Timestamp wsu:Id="Timestamp-3">
    <wsu:Created>2013-03-01T16:54:54.336</wsu:Created>
    <wsu:Expires>2013-03-01T16:59:54.336</wsu:Expires>
   </wsu:Timestamp>
================== SAML Token goes here
  </wsse:Security>
  <wsa:To soapenv:mustUnderstand="true">https://192.168.1.3:8443/axis2/services/Exchange</wsa:To>
  <wsa:ReplyTo soapenv:mustUnderstand="true">
   <wsa:Address>http://schemas.xmlsoap.org/ws/2004/08/addressing/role/anonymous</wsa:Address>
  </wsa:ReplyTo>
  <wsa:MessageID soapenv:mustUnderstand="true">urn:uuid:1_1362156894340</wsa:MessageID>
  <wsa:Action soapenv:mustUnderstand="true">urn:ihe:pcd:2010:CommunicatePCDData</wsa:Action>
 </soapenv:Header>
 <soapenv:Body>
  <pcd:CommunicatePCDData xmlns:pcd="urn:ihe:pcd:dec:2010">
MSH|^~\&amp;|LNI Example PHG^ECDE3D4E58532D31^EUI-64||||20130301115450.720-0500||ORU^R01^ORU_R01|
   0020130301115457201|P|2.6|||NE|AL|||||IHE PCD ORU-R012006^HL7^2.16.840.1.113883.9.n.m^HL7&#xD;
PID|||28da0026bc42484^^^&1.19.6.24.109.42.1.3&ISO^PI||Piggy^Sisansarah^L.^^^^L&#xD;
OBR|1|JOXP-PCD^LNI Example PHG^ECDE3D4E58532D31^EUI-64|
   JOXP-PCD^LNI Example PHG^ECDE3D4E58532D31^EUI-64|182777000^monitoring of patient^SNOMED-CT|||
   20130301115452.000-0500|20130301115455.001-0500&#xD;
OBX|1||531981^MDC_MOC_VMS_MDS_PHG^MDC|0|||||||X||||||ECDE3D4E58532D31^^ECDE3D4E58532D31^EUI-64&#xD;
OBX|2|CWE|68218^MDC_ATTR_REG_CERT_DATA_AUTH_BODY^MDC|0.0.0.1|2^auth-body-continua|||||R&#xD;
OBX|3|ST|532352^MDC_REG_CERT_DATA_CONTINUA_VERSION^MDC|0.0.0.1.1|2.0||||||R&#xD;
OBX|4|NM|532353^MDC_REG_CERT_DATA_CONTINUA_CERT_DEV_LIST^MDC|0.0.0.1.2|4||||||R&#xD;
OBX|5|CWE|68218^MDC__ATTR_REG_CERT_DATA_AUTH_BODY^MDC|0.0.0.2|2^auth-body-continua|||||R&#xD;
OBX|6|CWE|532354^MDC_REG_CERT_DATA_CONTINUA_REG_STATUS^MDC|0.0.0.2.1|1^unregulated(0)||||||R&#xD;
OBX|7|CWE|68218^MDC_REG_CERT_DATA_AUTH_BODY^MDC|0.0.0.3|2^auth-body-continua|||||R&#xD;
OBX|8|CWE|532355^MDC_REG_CERT_DATA_CONTINUA_PHG_CERT_LIST^MDC|0.0.0.3.1|0^observation-upload-
soap|||||R&#xD;
OBX|9|CWE|68220^MDC_TIME_SYNC_PROTOCOL^MDC|0.0.0.4|532234^MDC_TIME_SYNC_NONE^MDC|||||R&#xD;
OBX|10|NM|8221^MDC_TIME_SYNC_ACCURACY^MDC |0.0.0.5|120000000|264339^MDC_DIM_MICRO_SEC^MDC||||R&#xD;
OBX|11||528391^MDC_DEV_SPEC_PROFILE_BP^MDC|1|||||||X|||||||1234567800112233^^1234567800112233^EUI-
64&#xD;
OBX|12|ST|531970^MDC_ID_MODEL_MANUFACTURER^MDC|1.0.0.1|Lamprey Networks||||||R&#xD;
OBX|13|ST|531969^MDC_ID_MODEL_NUMBER^MDC|1.0.0.2|Blood Pressure 1.0.0||||||R&#xD;
OBX|14|CWE|68218^MDC_ATTR_REG_CERT_DATA_AUTH_BODY^MDC|1.0.0.3|2^auth-body-continua|||||R&#xD;
OBX|15|ST|532352^MDC_REG_CERT_DATA_CONTINUA_VERSION^MDC|1.0.0.3.1|2.0||||||R&#xD;
OBX|16|NM|532353^MDC_REG_CERT_DATA_CONTINUA_CERT_DEV_LIST^MDC|1.0.0.3.2|24583~8199~16391~7||||||R&#x
D;
OBX|17|CWE|68218^MDC_ATTR_REG_CERT_DATA_AUTH_BODY^MDC|1.0.0.4|2^auth-body-continua|||||R&#xD;
OBX|18|CWE|532354^MDC_REG_CERT_DATA_CONTINUA_REG_STATUS^MDC|1.0.0.4.1|1^unregulated(0)||||||R&#xD;
OBX|19|CWE|68219^MDC_TIME_CAP_STATE^MDC|1.0.0.5|1^mds-time-capab-real-time-clock(0)||||||R&#xD;
OBX|20|CWE|68220^MDC_TIME_SYNC_PROTOCOL^MDC|1.0.0.6|532224^MDC_TIME_SYNC_NONE^MDC|||||R&#xD;
OBX|21|DTM|67975^MDC_ATTR_TIME_ABS^MDC|1.0.0.7|20130301115423.00|||||R|||20130301115450.733-
0500&#xD;
OBX|22||150020^MDC_PRESS_BLD_NONINV^MDC|1.0.1||||||X|||20130301115452.733-0500&#xD;
OBX|23|NM|150021^MDC_PRESS_BLD_NONINV_SYS^MDC|1.0.1.1|105|266016^MDC_DIM_MMHG^MDC||||R&#xD;
OBX|24|NM|150022^MDC_PRESS_BLD_NONINV_DIA^MDC|1.0.1.2|70|266016^MDC_DIM_MMHG^MDC||||R&#xD;
OBX|25|NM|150023^MDC_PRESS_BLD_NONINV_MEAN^MDC|1.0.1.3|81.7|266016^MDC_DIM_MMHG^MDC||||R&#xD;
OBX|26|NM|149546^MDC_PULS_RATE_NON_INV^MDC|1.0.0.8|80|264864^MDC_DIM_BEAT_PER_MIN^MDC||||R|||201303
01115453.733-0500&#xD;
  </pcd:CommunicatePCDData>
 </soapenv:Body>
</soapenv:Envelope>
```

From the PCD-01 payload it is seen that the sensor is certified for multiple transports; Continua pre-Tcode* PHGs, USB, Bluetooth and ZigBee. The PHG is on a popular operating system and setting the time synchronization to eyeball and wrist watch which has a default accuracy of 120 seconds. The reason for these settings is that the popular operating system allows for user setting of the clock in addition to external synchronization but the operating system does not provide that information to applications. Note that the PID segment PID-3 CX-4 value is an affinity domain using the OID encoding system which is a universal ID type. CX-4 is an HD data type. See clause 9 for background information on PCD and its related terminology. The '&#xD' is an escaped carriage return (0x0D). If the 0x0D character is not escaped, SOAP receivers will convert this character to a line feed (0x0A) according to standard. Since the 0x0D character is the PCD-01 segment separator, it must be escaped in order to preserve it; otherwise the PCD-01 decoder will not be able to properly parse the message.

NOTE – *After version 1.0, Continua introduced a Tcode element that indicates the transports the specialization is certified for. The Tcode gets added to the specialization value resulting in a number that would be incomprehensible to version 1.0 PHGs. For backwards compatibility, sensors are allowed to provide the specialization with a Tcode value of 0 so version 1.0 PHGs would understand it.

### 8.10.4 CommunicatePCDData response

This response has an ERR segment with error 'accepted'. The ERR segment can be used to transfer optional information about the transaction and may be included in responses that contain no error. In this case the server has converted the PCD-01 document to a PHMR document and sent it successfully and that information is indicated in the ERR segment.

```
HTTP/1.1 200 OK
Server: Apache-Coyote/1.1
Content-Type: application/soap+xml;action="urn:ihe:pcd:2010:CommunicatePCDDataResponse";charset=UTF-
8
Transfer-Encoding: chunked
Date: Fri, 01 Mar 2013 16:54:41 GMT

<?xml version='1.0' encoding='UTF-8'?>
<soapenv:Envelope xmlns:soapenv="http://www.w3.org/2003/05/soap-envelope">
 <soapenv:Header xmlns:wsa="http://www.w3.org/2005/08/addressing">
  <wsse:Security
   xmlns:wsse="http://docs.oasis-open.org/wss/2004/01/oasis-200401-wss-wssecurity-secext-1.0.xsd"
   xmlns:wsu="http://docs.oasis-open.org/wss/2004/01/oasis-200401-wss-wssecurity-utility-1.0.xsd"
   soapenv:mustUnderstand="true">
   <wsu:Timestamp wsu:Id="TS-14">
    <wsu:Created>2013-03-01T16:54:41.458Z</wsu:Created>
    <wsu:Expires>2013-03-01T16:59:41.458Z</wsu:Expires>
   </wsu:Timestamp>
  </wsse:Security>
  <wsa:Action soapenv:mustUnderstand="true">urn:ihe:pcd:2010:CommunicatePCDDataResponse</wsa:Action>
  <wsa:RelatesTo soapenv:mustUnderstand="true">urn:uuid:1_1362156894340</wsa:RelatesTo>
 </soapenv:Header>
 <soapenv:Body>
  <pcd:CommunicatePCDDataResponse xmlns:pcd="urn:ihe:pcd:dec:2010">
MSH|^~\&amp;|LNI^d0bed0bed0beabee^EUI-64||||20130301115441.444-0500||ACK^R01^ACK|
  00120130301115453695|P|2.6|||NE|AL|||||IHE PCD ORU-R012006^HL7^2.16.840.1.113883.9.n.m^HL7&#xd;
MSA|AA|00120130301115453695&#xd;
ERR|||0^Message_accepted^HL7|I||||PcdToPHMR: XDS Send was successful. Response: null&#xd;
  </pcd:CommunicatePCDDataResponse>
 </soapenv:Body>
</soapenv:Envelope>
```

## 8.11 hData Observation Upload example

The following illustrates an example implementation of an Observation Upload using hData. It involves two stages. The first stage is requesting the oAuth token. How one obtains this token is not specified by Continua. In this case the username-password method is illustrated. The second stage is the upload of the PCD-01 document using the oAuth token obtained from the authorization service in stage one.

#### 8.11.1.1 oAuth bearer token request

```
POST /oAUTH_Service HTTP/1.1
Content-Type: application/x-www-form-urlencoded
User-Agent: HealthLink-mOXP
Host: 192.168.1.3:8443
Connection: Keep-Alive
Accept: application/x-www-form-urlencoded
Content-Length: 87
grant_type=password&username=Sisansarah&password=publicpassword&scope=ObservationUpload
```

#### 8.11.1.2 oAuth bearer token response

```
HTTP/1.1 200 OK
Server: Jetty/1.9
Content-Type: application/json;charset=UTF-8
Cache-Control: no-store
Pragma: no-cache
{
"access_token":"2YotnFZFEjr1zCsicMWpAA",
"token_type":"Bearer",
"expires_in":3600,
"refresh_token":"tGzv3JOkF0XG5Qx2TlKWIA",
"scope":"ObservationUpload"
}
```

#### 8.11.1.3 Observation Upload

Note that the relative URL '/PCD01_Upload' is obtained from the <path> element in the capability exchange.

```
POST /PCD01_Upload HTTP/1.1
Content-Type: application/txt
User-Agent: HealthLink-mOXP
Content-Encoding: UTF-8
Host: 192.168.1.3:8443
Connection: Keep-Alive
Accept: application/txt
Authorization: Bearer 2YotnFZFEjr1zCsicMWpAA
Content-Length: 2818
MSH|^~\&amp;|LNI Example PHG^ECDE3D4E58532D31^EUI-64||||20130301115450.720-0500||ORU^R01^ORU_R01|
   0020130301115455720|P|2.6|||NE|AL|||||IHE PCD ORU-R012006^HL7^2.16.840.1.113883.9.n.m^HL7&#xD;
PID|||28da0026bc42484^^^&1.19.6.24.109.42.1.3&ISO^PI||Piggy^Sisansarah^L.^^^^L&#xD;
OBR|1|JOXP-PCD^LNI Example PHG^ECDE3D4E58532D31^EUI-64|
   JOXP-PCD^LNI Example PHG^ECDE3D4E58532D31^EUI-64|182777000^monitoring of patient^SNOMED-CT|||
   20130301115452.000-0500|20130301115455.001-0500&#xD;
OBX|1||531981^MDC_MOC_VMS_MDS_PHG^MDC|0|||||||X||||||ECDE3D4E58532D31^^ECDE3D4E58532D31^EUI-64&#xD;
OBX|2|CWE|68218^MDC_ATTR_REG_CERT_DATA_AUTH_BODY^MDC|0.0.0.1|2^auth-body-continua||||||R&#xD;
OBX|3|ST|532352^MDC_REG_CERT_DATA_CONTINUA_VERSION^MDC|0.0.0.1.1|2.0||||||R&#xD;
OBX|4|NM|532353^MDC_REG_CERT_DATA_CONTINUA_CERT_DEV_LIST^MDC|0.0.0.1.2|4||||||R&#xD;
OBX|5|CWE|68218^MDC_ATTR_REG_CERT_DATA_AUTH_BODY^MDC|0.0.0.2|2^auth-body-continua||||||R&#xD;
OBX|6|CWE|532354^MDC_REG_CERT_DATA_CONTINUA_REG_STATUS^MDC|0.0.0.2.1|1^unregulated(0)||||||R&#xD;
OBX|7|CWE|68218^MDC_REG_CERT_DATA_AUTH_BODY^MDC|0.0.0.3|2^auth-body-continua||||||R&#xD;
OBX|8|CWE|532355^MDC_REG_CERT_DATA_CONTINUA_PHG_CERT_LIST^MDC|0.0.0.3.1|0^observation-upload-
soap||||||R&#xD;
OBX|9|CWE|68220^MDC_TIME_SYNC_PROTOCOL^MDC|0.0.0.4|532234^MDC_TIME_SYNC_NONE^MDC||||||R&#xD;
OBX|10|NM|8221^MDC_TIME_SYNC_ACCURACY^MDC |0.0.0.5|120000000|264339^MDC_DIM_MICRO_SEC^MDC|||||R&#xD;
OBX|11||528391^MDC_DEV_SPEC_PROFILE_BP^MDC|1|||||||X|||||||1234567800112233^^1234567800112233^EUI-
64&#xD;
OBX|12|ST|531970^MDC_ID_MODEL_MANUFACTURER^MDC|1.0.0.1|Lamprey Networks||||||R&#xD;
OBX|13|ST|531969^MDC_ID_MODEL_NUMBER^MDC|1.0.0.2|Blood Pressure 1.0.0||||||R&#xD;
OBX|14|CWE|68218^MDC_ATTR_REG_CERT_DATA_AUTH_BODY^MDC|1.0.0.3|2^auth-body-continua||||||R&#xD;
OBX|15|ST|532352^MDC_REG_CERT_DATA_CONTINUA_VERSION^MDC|1.0.0.3.1|2.0||||||R&#xD;
OBX|16|NM|532353^MDC_REG_CERT_DATA_CONTINUA_CERT_DEV_LIST^MDC|1.0.0.3.2|24583~8199~16391~7||||||R&#x
D;
OBX|17|CWE|68218^MDC_ATTR_REG_CERT_DATA_AUTH_BODY^MDC|1.0.0.4|2^auth-body-continua||||||R&#xD;
OBX|18|CWE|532354^MDC_REG_CERT_DATA_CONTINUA_REG_STATUS^MDC|1.0.0.4.1|1^unregulated(0)||||||R&#xD;
OBX|19|CWE|68219^MDC_TIME_CAP_STATE^MDC|1.0.0.5|1^mds-time-capab-real-time-clock(0)||||||R&#xD;
OBX|20|CWE|68220^MDC_TIME_SYNC_PROTOCOL^MDC|1.0.0.6|532224^MDC_TIME_SYNC_NONE^MDC||||||R&#xD;
OBX|21|DTM|67975^MDC_ATTR_TIME_ABS^MDC|1.0.0.7|20130301115423.00||||||R|||20130301115450.733-
0500&#xD;
OBX|22||150020^MDC_PRESS_BLD_NONINV^MDC|1.0.1|||||||X|||20130301115452.733-0500&#xD;
OBX|23|NM|150021^MDC_PRESS_BLD_NONINV_SYS^MDC|1.0.1.1|105|266016^MDC_DIM_MMHG^MDC|||||R&#xD;
OBX|24|NM|150022^MDC_PRESS_BLD_NONINV_DIA^MDC|1.0.1.2|70|266016^MDC_DIM_MMHG^MDC|||||R&#xD;
```

```
OBX|25|NM|150023^MDC_PRESS_BLD_NONINV_MEAN^MDC|1.0.1.3|81.7|266016^MDC_DIM_MMHG^MDC|||||R&#xD;
OBX|26|NM|149546^MDC_PULS_RATE_NON_INV^MDC|1.0.0.8|80|264864^MDC_DIM_BEAT_PER_MIN^MDC|||||R|||201303
01115453.733-0500&#xD;
```

# 9 The PCD-01 document payload

A PCD-01 document is used to communicate observations over the services interface. An observation has certain properties that must be assured by the PHG application to provide proper mapping and understanding by downstream systems. Continua has chosen the PCD-01 document standard as the means to package the observations. PCD-01 is an HL7 version 2 type message. The messages have an XML and an EDI form. Continua requires the EDI form. One advantage of the EDI form is that it is the most efficient of the two messaging formats for transferring data over the wire. It is also human readable.

The PCD-01 payload is independent of the transport method; document creation is the same whether one uses hData or SOAP.

The primary source of guidance for creating PCD-01 documents comes from the IHE Patient Care Device Technical Framework Volume 2 Transactions [IHE PCD-01].

## 9.1 PCD-01 fundamentals

An EDI-formatted PCD-01 document consists of a set of segments that look like the following:

```
OBX|9|NM|150456^MDC_PULS_OXIM_SAT_O2^MDC|1.0.0.5|98|262688^MDC_DIM_PERCENT^
MDC|||||R
```

Each segment starts with a certain recognized segment header code word (MSH, PID, OBR, OBX, etc.) identifying the segment and is terminated by a carriage return (0x0D).

From Table 3.1.4.1.1-1 in [IHE PCD-01], it is seen that PCD-01 allows seven types of segments, three of which are optional. These optional segments are rare in the Continua home environment and their formatting and construction are given limited discussion. The four segments that are of relevance are the message header (MSH), the patient identifier (PID), the observation request (OBR), and the observation result (OBX).

### 9.1.1 MSH header

The MSH segment is self-explanatory; every document needs some type of header. Most of the information in this segment is static. One of the more important fields in this header is a static entry stating that the document is an unsolicited request. In certain HL7 scenarios a request is made to a department for a service to be performed. Once the service is performed, the response is sent back to the requester. In the unsolicited case, a request is often *assumed*. The end recipient receives the document whenever it is generated. The code `ORU^R01^ORU_R01` in the header indicates that the message is an unsolicited request.

### 9.1.2 PID patient info

The PID segment contains patient information. Most of it is demographic information but there is also a set of required entries representing patient identifier codes that only mean something to the end recipient of the document. These codes must be obtained from the recipient out of band; they are not obtained from the sensor devices. One of these components is the patient ID that uniquely identifies the patient to the receiving application/institution. The patient ID bears no relation to the ISO/IEEE 11073-20601 person id though the PHG may use the person id from a given device as a database key to obtain the values to populate the PID segment.

### 9.1.3 OBR observation request

The OBR segment is the observation request itself and it typically contains the details of the request. In the unsolicited case many of these entries are not applicable and are filled with canned values that indicate the unsolicited nature of the request. The OBR also contains the start and end times of the measurements. A PCD-01 document may have more than one OBR segment though it is common to have only one.

### 9.1.4 OBX observation result

The OBX segments represent the observation results in response to the OBR. In the Continua environment OBX segments are also used to report information about the PHG and the sensor device. Most importantly it reports the observation itself.

Each OBX provides a key/value pair where the key is an observation identifier and the value is the observation value. Supporting items in the OBX provide additional information about the value such as its units (if any) and timestamp. There is also information in the OBX that specifies how the value is formatted (number, string, etc.) so the end user can read it. The observation identifiers come from the medical device communication code set (the partition/nomenclature codes). The data transmitted from the sensor device is mapped to the OBX entries. It is important to note that the Services interface has no corollary concept to ISO/IEEE 11073-20601 entities that are used to format and transfer the data across the personal health device interface such as PM-Stores, Scanners, object handles, attribute value maps and configuration ids. Information to be delivered using the services interface arriving via these entities must be broken into their constituent observations and translated accordingly.

A second important concept is the observation hierarchy. An observational attribute transmitted from a sensor device often has significant contextual information associated with it. The services interface requires that this contextual information be grouped into logical collections so that a particular group contains all the data relevant for the complete understanding of an observation. In many cases, a single OBX segment describes the measurement and its context. In some cases additional OBX segments are required. These segments are grouped by the observation hierarchy (also known as the containment hierarchy). The hierarchy entry uses a dotted notation to specify which OBX segments are children of a parent OBX. Examples are an [ISO/IEEE 11073-20601] blood pressure reading that contain systolic pressure, diastolic pressure and mean arterial pressure (plus all associated units) or a pulse oximeter reading containing a supplemental-types attribute. In the first case the systolic, diastolic and MAP values are child OBXes of the parent OBX that designates the non-invasive blood pressure reading. In the pulse oximeter case there happens to be no field available in OBXes containing the $SpO_2$ and pulse rate information for the supplemental-types. Thus a child OBX is needed in each case for this information.

For the implementer, the generation of OBX segments constitutes the bulk of the work. Even the simplest possible Continua PCD-01 document will contain several OBX segments.

## 9.2 Document structure

Table 9-1 contains a simplified version of the table in [IHE PCD-01] that contains only the required (**bold** text) and optional segments of a PCD-01 document.

**Table 9-1 – Simplified PCD-01 table**

| Segment | Meaning | Usage | Cardinality |
|---|---|---|---|
| **MSH** | **Message Header** | **Required** | **[1..1]** |
| { | --- PATIENT_RESULT begin | | |
| | --- PATIENT begin | | |
| **[PID]** | **Patient Identification** | **Required** | **[1..1]** |
| [PV1] | Patient Visit | Optional | [0..1] |
| | --- PATIENT end | | |
| { | ---ORDER_OBSERVATION begin | | |
| **OBR** | **Observation Request** | **Required** | **[1..*]** |
| [NTE] | Notes and comments | Optional | [0..1] |
| [TQ1] | Timing/Quantity | Optional | [0..1] |
| [{ | --- OBSERVATION begin | | |
| **OBX** | **Observation Result** | **Required** | **[1..*]** |
| [NTE] | Notes and comments | Optional | [0..1] |
| }] | --- OBSERVATION end | | |
| } | --- ORDER_OBSERVATION end | | |
| } | --- PATIENT_RESULT end | | |

In Table 9-1, the curly bracket symbol ({) shows what each segment scopes and the cardinality shows how many times the segment may appear in a given document. From this table one sees that a PCD-01 document consists of one and only one MSH segment and one and only one PID segment which may be followed by at most one PV1 segment. Note that a PCD-01 document *always* refers to one and only one patient.

A given document contains at least one OBR segment but may contain more. The OBR segment, in turn, scopes at least one OBX segment but may contain more. Each OBR may be followed by one optional NTE and/or TQ1 segment and each OBX may be followed by one NTE segment. Continua makes no requirements about the use of any of the optional segments. Details on the construction and use of these segments are found in [IHE PCD-01] and their usage is up to the implementer.

### 9.3 PHG, MDS and metric OBXes

A Continua PCD-01 document will always contain *several* OBX segments in every OBR segment even if the sensor device sends only a single measurement. The reason for the numerous OBX segments is that Continua requires that the *first* OBR of the document contains a set of OBX segments that describes the features of the PHG. These OBX segments are referred to as **PHG-OBXes**. These PHG-OBXes describe features like what sensor specializations and Continua version the PHG has been certified for, its regulation status, the health and fitness service classes it has been certified for, and its time synchronization properties. In addition to the PHG-OBXes, Continua requires that *every* OBR segment also contain a set of OBXes that describe the sensor device. These OBX segments are referred to as **MDS-OBXes** since these segments are populated by values that come from attributes in the sensor's MDS object*. One then has the OBX segments that represent physiological measurements. These OBX segments are referred to as **Metric-OBXes** since they originate from metric objects* on the sensor. Metric OBXes are created when the PHG receives scan event reports* or segment data events* whose observation scans* contain at least one observational attribute.

NOTE * – For Bluetooth low energy (Bluetooth LE) devices the white paper [Bluetooth PHDT] provides the matching between the Bluetooth LE services and attributes and the above [ISO/IEEE 11073-20601] representations. As an example, the MDS-OBXes would be populated from the attributes contained in the device information service and whatever current time algorithm the device supports.

Given the above, the simplest Continua PCD-01 document appears schematically as follows:

```
MSH
PID
OBR
     Set of PHG-OBXes
     Set of MDS-OBXes
     Metric OBXes.
```

It is also possible for a given OBR segment to contain multiple sets of MDS-OBXes. This situation happens if the application wishes to place data received from multiple sensors or the results of a reassociation of the same sensor in a single OBR. The text in [IHE PCD-01] "An OBR Segment will be used for each set of such OBX segments to establish the equipment context for the observations (i.e., whether the interrogation was done in-clinic or remote)" may suggest otherwise but that statement is not applicable to different sensors in the same environment on the same person. When OBXes for an additional sensor (or reassociation of the same sensor) are included the set of MDS-OBXes for the additional sensors (or reassociated sensor) must also be present. In this case the different sensors are being mapped to the same timeline by the PHG. Thus the PCD-01 document might appear schematically as:

```
MSH
PID
OBR
     Set of PHG-OBXes
     Set of MDS-OBXes for sensor 1
     Metric OBXes for sensor 1

     Set of MDS-OBXes for sensor n
     Metric OBXes for sensor n
```

Alternatively, if the application chose to place the OBX segments from each sensor or the reassociation in its own OBR, the document might appear as:

```
MSH
PID
OBR # 1
     Set of PHG-OBXes
     Set of MDS-OBXes for sensor 1
     Metric OBXes for sensor 1

OBR # n
     Set of MDS-OBXes for sensor n
     Metric OBXes for sensor n
```

or as some other combination. Note that in all cases the PHG-OBXes appear *only* in the first OBR of the document.

New OBR segments are *always* generated when the time line of a single sensor is broken; for example, when the PHG receives a date-time-adjustment from the sensor.

## 9.4 Segment structure

Segment entries are referred to as *Fields*. A given Field entry may have several *Components*, and a given component may have *Sub-Components*. Within a Field, a component may be repeated. A set of special delimiter characters is used to separate these entities; a field separator, component separator, sub-component separator and repetition separator. In theory these characters can be anything and are up to the implementer. However, everyone always uses the same set of separators; the OR-bar (|), carat (^), ampersand (&) and tilde (~), respectively. Furthermore, the PCD-01 specification [IHE PCD-01] *requires* that these four separators are used. There is also an escaping symbol that is defined in the grouping. If the PCD-01 message needs to escape some character, this symbol is used. The use of this symbol would occur when a character in the message is one of the separator symbols. In theory this symbol is also up to the implementer. However, the backslash (\) is always used and once again, the PCD-01 specification [IHE PCD-01] requires that the escape symbol be the backslash. It should be noted that HL7 escapes separators in the following way:

\F\ for the field separator

\S\ for a component separator

\T\ for a sub component separator

\R\ for a repetition separator

\E\ for the escape character.

Thus, if the string "The separator characters |^&\~ are used in PCD-01." ever showed up in a string data type in a PCD-01 message, it would appear as:

The separator characters \F\\S\\T\\E\\R\ are used in PCD-01.

The following is an example of how fields, components, sub-components and repetitions might appear in a segment:

|compa$_1$^compb$_1$^compc$_1$&suba$_1$&subb$_1$^compd$_1$~compa$_2$^compb$_2$^compc$_2$&suba$_2$&subb$_2$^compd$_2$|field2|field3|

They can be empty:

|compa$_1$^^compc$_1$&&subb$_1$^compd$_1$~compa$_2$^^compc$_2$&&subb$_2$^compd$_2$||field3|

The separators (shown **bold** below) are defined at the beginning of the MSH segment, an example of which is as follows:

```
MSH|^~\&|Example PHG^FEEDABEEDEADBEEF^EUI-64||||
20111128105910.708-0500||ORU^R01^ORU_R01|00320111128105910708|P|2.6|||NE|AL|||||
IHE PCD ORU-R012006^HL7^2.16.840.1.113883.9.n.m^HL7
```

The field separator is defined as the first character appearing after the MSH identifier. In the above example it is the standard OR-bar (|). It is legal in generic HL7 messages (but illegal in PCD-01) to do as follows:

```
MSH=^~\&=Example PHG^FEEDABEEDEADBEEF^EUI-64====
20111128105910.708-0500==ORU^R01^ORU_R01=00320111128105910708=P=2.6===NE=AL=====
IHE PCD ORU-R012006^HL7^2.16.840.1.113883.9.n.m^HL7
```

where the field separator (shown **bold** above) has been defined as the equal (=) sign. If an equal sign appears in any one of the field values, it would need to be escaped with the escape symbol (\) and would look like \F\ in the PCD message where '\F\' would be replaced by '=' when unescaping.

A field is the value contained between the OR-bars. Empty fields are designated by two separators with nothing in them, for example ||. Continua encourages users to terminate the segment when the last non-empty field is in place (it is a '**should'** and not a '**shall'**). A terminating separator is not needed on that last field; the segment terminator is sufficient. The following is desired:

```
OBX|9|NM|150456^MDC_PULS_OXIM_SAT_O2^MDC|1.0.0.5|98|262688^MDC_DIM_PERCENT^MDC|||||R
```

though it is also legal to do

```
OBX|9|NM|150456^MDC_PULS_OXIM_SAT_O2^MDC|1.0.0.5|98|262688^MDC_DIM_PERCENT^MDC|||||R|
```

or

```
OBX|9|NM|150456^MDC_PULS_OXIM_SAT_O2^MDC|1.0.0.5|98|262688^MDC_DIM_PERCENT^MDC|||||R||||
```

It is common practice to refer to the fields of a given segment using the expression 'segment name – number', for example, OBX-3. Appendix B of [IHE PCD-01] makes extensive use of this notation to explain in detail what each field in each segment type contains. In the following segment––

```
OBX|9|NM|150456^MDC_PULS_OXIM_SAT_O2^MDC|1.0.0.5|98|262688^MDC_DIM_PERCENT^
MDC|||||R
```

Where:

– OBX-1 is `9`

– OBX-2 is `NM`

– OBX-3 is 150456^MDC_PULS_OXIM_SAT_O2^MDC

– OBX-4 is `1.0.0.5`,

– …

– OBX-7 is empty,

– …

– OBX-11 is `R`, and

– OBX-12 through OBX-20 are all empty and therefore not included.

There are two possible points of confusion when using this notation. Since there may be multiple OBR and OBX segments in a given document, these segments also have sequence numbers. The following section of a PCD-01 document

```
OBR|1|JOXP-PCD^Example PHG^FEEDABEEDEADBEEF^EUI-64|JOXP-PCD^Example PHG^FEEDABEEDEADBEEF^EUI-
64|182777000^monitoring of patient^SNOMED-CT|||20111128105909.236-0500|20111128105911.237-0500
OBX|1||531981^MDC_MOC_VMS_MDS_PHG^MDC|0||||||X|||||||FEEDABEEDEADBEEF^^FEEDABEEDEADBEEF^EUI-
64
OBX|2|CWE|68218^MDC_ATTR_REG_CERT_DATA_AUTH_BODY^MDC|0.0.0.1|2^auth-body-continua|||||R
OBX|3|ST|532352^MDC_REG_CERT_DATA_CONTINUA_VERSION^MDC|0.0.0.1.1|1.5|||||R
OBX|4|NM|532353^MDC_REG_CERT_DATA_CONTINUA_CERT_DEV_LIST^MDC|0.0.0.1.2|16391~8199|||||R
```

illustrates sequence numbers (**bold**). They are given in OBR-1 and OBX-1. It is easy to think that OBX-3 refers to the OBX segment with sequence number 3. It is not. OBX-3 is the third field of any OBX segment. In the case of the OBX with sequence number 3, OBX-3 is the string `532352^MDC_REG_CERT_DATA_CONTINUA_VERSION^MDC`.

Given that, there is a twist when identifying the nth field of the MSH header:

```
MSH|^~\&|Example PHG^FEEDABEEDEADBEEF^EUI-64||||
20111128105910.708-0500||ORU^R01^ORU_R01|00320111128105910708|P|2.6|||NE|AL|||||
IHE PCD ORU-R012006^HL7^2.16.840.1.113883.9.n.m^HL7
```

One might be inclined to believe that MSH-1 in the example above is the set of characters ^~\&. However, it is the '**|**' after the MSH designator. That is because the first field in the MSH segment *defines* the field separator which is then used in the rest of the PCD-01 document as a separator. So the first | of the MSH segment (and only the MSH segment) is a field and not a field separator. MSH-2 is ^~\& which defines the remaining separators and escape symbols.

The component separator ^ delineates parts of a single field. A good example for the use of the component separator would be when reporting the three components of an acceleration, $|x_1$^$y_1$^$z_1|$. All three components are needed to describe the single acceleration measurement. The repetition character ~ would be used if one is reporting a sequence of acceleration measurements (perhaps at different times) within a single field $|x_1$^$y_1$^$z_1$~ $x_2$^$y_2$^$z_2$~ $x_3$^$y_3$^$z_3|$. Each $x_n$^$y_n$^$z_n$ entry completely describes a given entity/measurement. The concept is that the component separator is used when the entity or measurement needs to be represented in parts but only when all the parts are put together does one completely describe the entity/measurement. The repetition character is used when the entity/measurement is of the same type but there are multiple occurrences. Each entry between the repetition character completely describes the entity/measurement.

An additional example of a field that has components is the patient's name in the PID segment. It consists of several components; family name, first name, middle name, title, suffix, etc. These components are all separated by ^ since together they identify the patient. On the other hand, fields containing lists would use the repetition character. One of the MDS-OBXes reports the specializations supported by a given sensor. If the sensor supports more than one specialization, the specialization entries are separated by ~.

The sub-component separator & is used when a component itself consists of several parts. This situation is rare in the Continua environment.

### 9.5 PCD-01 format "on the wire"

The default encoding of the segments and fields of a PCD-01 document on the wire is using the ASCII-127 character set. However, other formats are allowed including non-alphabetic character sets. The entire list is given in Table 0211 located in Version 2.6 Chapter 2 Control of the HL7 standard. Which character encoding is used is specified in MSH-18. If MSH-18 is empty, the encoding defaults to ASCII-127. However, in Continua where the [ISO/IEEE 11073-20601] specification requires the use of ASCII-127 in string values, PCD-01 tends to be either ASCII-127 or Unicode UTF-8. Using UTF-8 would allow, for example, non ASCII-127 fields in the MSH, PID and OBR segments whose fields are not derived from [ISO/IEEE 11073-20601] transactions while being compatible with the ASCII-127 fields in the OBX segments.

### 9.6 HL7 data types

Each field in each OBX segment is a pre-specified HL7 *data type*. Within a given field the allowed data type may repeat. There are numerous HL7 data types. Some of them are quite complex and contain several components whereas others consist of a single component. Some data types nest other data types. The data type NM is an example of a simple data type. It states that the field is a number (containing only digits, +, − and.). The most common data types that are used in PCD-01 are given in [IHE PCD-01] Table C-1 and are described in detail in [IHE PCD-01] Appendix C. Data types, like segments, are terminated at their last non-empty component. A terminating ^ is also not needed; another terminating symbol will always be present (for example, a field or repetition symbol) and suffices.

Some of the rules for data type usage have been restricted by Continua services design guidelines; in particular which components of the data type are allowed to be empty and which are not. The Coded With Exceptions (CWE) data type is used in these guidelines when representing nomenclature codes. In HL7 this data type has nine components, the first six of which are required. HL7 allows all components to be empty *except* the second. When coding nomenclature codes, Continua allows the second, fourth, fifth and sixth component to be empty and requires entries in the first and third component.

The reason for this deviation from HL7 becomes apparent when one examines how the CWE type is used when encoding nomenclature values. The first component is the code (partition and nomenclature), the second is the reference Id that names the code, and the third is the coding system (which is always MDC in Continua use cases). An example of a CWE encoded oxygen saturation code on the pulse oximeter would be `150456^MDC_PULS_OXIM_SAT_O2^MDC`. A PHG receives *only* the code on the wire. The associated name must be looked up in some type of database. For future specializations and private (proprietary) nomenclature codes, the name of the code may not be known. If the name is allowed to be empty, the PHG can still create a PCD-01 document using just the code and coding system, for example `150456^^MDC`. This construction allows the existence of headless service PHGs that simply pass the information collected from sensors to a back end. The same applies when these guidelines are used to encode the ASN.1-BITS fields as a CWE data type.

Data types use the same 'index notation' to identify their components as segments. CWE-2 identifies the second component of the CWE data-type and EI-3 means the third component of the EI data type. There is no such standard designation for the n-th repetition of a data type.

The only HL7 data types used in PCD-01 OBX segments created from ISO/IEEE 11073-20601 sensors are:

| | |
|---|---|
| CWE | Coded With Exceptions (used for MDC codes, BITS fields and integer enumerations) Used whenever one has a code that has a specific meaning |
| DTM | Date Time (used for timestamps) |
| EI | Entity Identifier |
| NM | A number |
| ST | A string |
| NA | An array of numbers (used in RTSAs) |

The entity identifier (EI) was incorrectly represented in some cases in versions prior to these guidelines and has caused confusion. The EI data type has four components; the first two are used when a locally defined coding system is used, and the last two are used when a universally defined coding system is used. "*EUI-64*"s and "*OID*"s are an example of universal ID types, thus coding something like an ISO/IEEE 11073-20601 system id requires the use of EI-3 for the system id with an EI-4 value of "*EUI-64*". It should also be noted that HL7 requires an entry for EI-1 even in the universal-id case. A compliant entry for "EUI-64" type codes in EI-1 would be a duplicate of the EI-3 entry, for example `FEEDABEEDEADBEEF^^FEEDABEEDEADBEEF^EUI-64`. It could also be `Continua_PHG_4.0^^FEEDABEEDEADBEEF^EUI-64`.

The following is NOT correct: `FEEDABEEDEADBEEF^EUI-64`

## 9.7 PID segment

There are two fields in the PID segment that are required. One is the patient identifier (PID-3) and the other is the patient name (PID-5). The patient name is self-explanatory. It is represented by the XPN data type which contains multiple components; family name, given (first) name, middle name, suffixes (like Sr. or Jr.), etc. See Table E.59 for details. The patient identifier, on the other hand, is a set of opaque codes that only mean something to the eventual recipient of the document. In HL7 XDSb transactions these codes are used to authenticate and identify the user to the document registry. The use of these codes is ubiquitous in HL7 Connectathons.

The CX data type contains three required entries, the ID (CX-1) which is a string, the assigning authority which is an HD data type (CX-4), and the identifier type code which is an ID (CX-5). In HL7 CX-5 may be empty. In most cases only the first component of the HD data type is used when representing the assigning authority. The ID and assigning authority are provided by the institution maintaining the registry. The assigning authority is often the affinity domain which is a code that identifies the enterprise the institution belongs to. CX-5 is a string code whose possible values are one of 97 given in Table 0203 in HL7 CH02A DataTypes. The code "PI" is defined as a 'Patient Internal Identifier' which is a number that is unique to a patient within an Assigning Authority. This code suffices for most Continua use cases.

If the assigning authority value in CX-4 is one of the universal identifiers like an EUI-64, ISO, or OID, instead of a local identifier, subfields of the HD data type are required. This situation requires the use of the sub-component delimiter (&). An example would be

```
PID|||28da0026bc42484^^^&1.19.6.24.109.42.1.3&ISO^PI||Piggy^Sisansarah^^^^^
L&#xD;
```

This type of identity code is ubiquitous identifying HL7 enterprise affinity domains.

The challenge is that none of the necessary data for these fields is provided by the sensors. Therefore, the PHG needs to provide this information, for example, through the use of the ISO/IEEE 11073-20601 person-id and sensor system-id as a key to a database containing all the necessary codes, patient name, and any other PID related demographic information one may wish to provide. If it is known that the end recipient is not going to use the patient identifier (PID-3) one can enter anything into these fields though it may be more appropriate in that case to use PT for CX-5, which is an external patient identifier, instead of PI which is associated with an HL7 affinity domain.

## 10 OBX segment fundamentals

This clause covers the fundamentals of generating OBX segments from 11073-20601 data.

### 10.1 Encoding OBX segments

An OBX segment is a key-value pair where the key indicates what the value is. The key is placed in OBX-3 and the value in OBX-5. The remaining fields provide support and organizational information for this key-value pair. There are 20 possible fields in a PDC-01 OBX segment. Continua PCD-01 OBX segments use about half of them.

The role of each field is illustrated using an OBX segment generated from an ISO/IEEE 11073-20601 scan event report containing a weight measurement. The scan event report's observation-scan contains a basic-nu-observed-value, timestamp, and object handle value. The handle points to the MDC_MASS_BODY_ACTUAL numeric metric object maintained by the PHG for context. The generated segment appears as follows:

```
OBX|26|NM|188736^MDC_MASS_BODY_ACTUAL^MDC|1.0.0.13|70.7|263875^MDC_DIM_KILO_G^MDC|||||R|||2012
0628145624.000-0500
```

**OBX-1** is the *sequence number* which in this case is 26. It starts at one and increases by one for each new OBX segment in an OBR. For a new OBR, the process repeats. Its purpose is purely organizational and indicates the order in which the segments are added to the OBR. The '26' in the example indicates there are 25 OBX segments prior to this one in this particular OBR.

**OBX-2** is the HL7 data type of the value which appears in OBX-5. This standard specifies how the ISO/IEEE 11073-20601 attribute value is mapped to the HL7 data type. For example, basic-nu and simple-nu observational attributes are mapped to the NM data type which is a number. Thus the 70.7 in OBX-5 is interpreted as a number.

**OBX-3** states what the value in OBX-5 actually *is* (a temperature, a device serial number, etc.). For Continua PCD-01 OBX-3 is always expressed as an MDC nomenclature code using the CWE data type. In this case OBX-3 comes from the TYPE attribute of the context body-mass metric object maintained by the PHG. The `MDC_MASS_BODY_ACTUAL` indicates that the number in OBX-5 represents a body mass.

**OBX-4** is the hierarchy. It groups OBX segments together, for example when more than one OBX segments are needed to describe a measurement. The hierarchy is discussed in clause 10.2.

**OBX-5** is the value. In this case it is the body mass 70.7. It is obtained from the basic-nu attribute value. It is possible that OBX-5 is empty but for OBXes containing physiological measurements an empty value only happens if a special value like a NaN is received.

**OBX-6** gives the units for the value in OBX-5. For Continua PCD-01 the units are always expressed as an MDC nomenclature code using the CWE data type. If the measurement has no units (for example the medication monitor feedback entries) this field is empty. In the case above, the `MDC_DIM_KILO_G` entry is obtained from the unit code attribute of the context body-mass metric object maintained by the PHG. Thus the 70.7 in OBX-5 is kilograms.

**OBX-8** (empty in the example) would be non-empty if the ISO/IEEE 11073-20601 scan event report observation scan contains a Measurement Status attribute or the measurement value is one of the special values (NaN, +/- Infinity, etc.). An entry in OBX-8 will affect the value in OBX-11.

**OBX-11** is a terse indicator of the measurement status. This field is always valued and for physiological measurements it is 'R' (results entered – not verified) unless an OBX-8 entry alters it. For OBX segments that have no OBX-5 value, this entry is 'X' (results cannot be obtained for this observation).

**OBX-14** is the timestamp of the measurement formatted as a DTM data type. Ideally the PHG presents the sensor's timestamp as local time plus offset to UTC time. If the sensor's time synchronization is superior to the PHG's, the PHG uses the sensor's time exclusively. The offset in the DTM data type is the number of hours one adds/subtracts to/from the UTC time to get the local time. The subject of timestamps is complex and the clause D.1.5 Timestamping and time synchronization in the guidelines is dedicated to it.

**OBX-18** is only used in PHG and MDS OBX segments as it identifies the equipment; PHG or sensor.

**OBX-20** is used for indicating the body sight of a measurement. In Continua usage it is only populated when a Supplemental-Types attribute has an entry whose partition value is MDC_PART_SITES.

## 10.2 Object hierarchy

The object hierarchy is a means to indicate scoping; in other words which OBX segments are children of other OBX segments. It allows OBX segments to be grouped into sets. A "dotted-notation" is used to indicate the hierarchy. This notation consists of a numeric tuple with a dot in-between the members which indicate a particular item's place in the object hierarchy. [IHE PCD-01] defines the hierarchy as containing the following levels:

```
MDS [. VMD [. CHANNEL [. METRIC [. FACET [. SUBFACET]]]]].
```

An example might be |3.0.3.2.1.1|. In Figure 10-1 is an example of several 'segments' that illustrate the containment hierarchy concept. For brevity, only the OBX-4 hierarchy field of the OBX segments is shown.

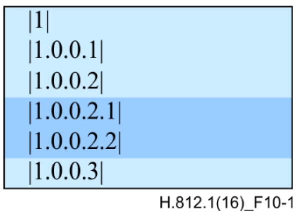


**Figure 10-1 – Containment hierarchy**

Since the MDS-tuple in each case above has the same value, all the segments are part of a single MDS object. In the ISO/IEEE 11073-20601 case that would mean they all originate from the same association. Within the segments the set that has the same METRIC-tuple '2' indicates that whatever is being described here needs all three segments to complete the description.

### 10.2.1 Hierarchy levels

The five levels MDS, VMD, CHANNEL, METRIC, FACET and SUBFACET are defined in [IEEE 11073-10201]. In [ISO/IEEE 11073-20601], the virtual medical device (VMD) is not used and thus its 'tuple' value is always 0.

The MDS level in [ISO/IEEE 11073-20601] defines the association. The hierarchy is started with the set |*x*.0.0.0| or |*x*| for brevity; it is common practice to leave off trailing tuples that are all 0. '*x*' is the MDS object *instance* and bears no relation to the MDS object handle. '*x*' is often 1 but it can be anything except 0 even if there is only one association represented ($x$ = 0 is reserved for PHG-OBXes). If a new association takes place and the OBX segments are placed under the same OBR, a new MDS instance value would be needed. Typically the index is incremented to maintain dictionary ordering but all that is required is that it be different.

Semantically, the CHANNEL is not present in 11073-20601. In [ISO/IEEE 11073-20601] metrics from different sensors, locations, or sources can be represented as coming over different channels. However, the Channel placeholder tuple is 'borrowed' in Continua PCD-01 when compound numeric attributes are translated. The compound TYPE is placed on the channel and the individual compound entries are placed at the METRIC-level instead of placing the TYPE at the METRIC-level and making the compound entries facets. This usage is confusing to new readers familiar with the ISO/IEEE 11073-20601 semantic meaning of a compound value. The reason for its usage is to reduce the number of extra facets and subfacet levels that might be needed in the compound case over that of the non-compound case. If it were possible to have facets of the individual compound entries, then the approach would reduce the need for extra facet levels. At this time the current version of [ISO/IEEE 11073-20601] does not result in any facets or subfacets to the compound entries.

The METRIC object level represents the measurement or item, or as stated in [IHE PCD-01] the "parametric instance". Like the MDS object level, it is an *instance* of a metric and bears no relation to the ISO/IEEE 11073-20601 handle value of a given object. Each new measurement/item is designated by a different instance value even if they come from the same ISO/IEEE 11073-20601 object.

The FACET and SUBFACET are used when an IEEE 11073-20601 measurement or item contains information that cannot find a place in the parent OBX. In a colloquial sense one could say the parent OBX has run out of acceptable fields for this additional information. An example would be a pulse oximeter measurement containing a supplemental-types attribute. The supplemental types attribute contains a list of one or more MDC codes. In the parent OBX, all candidate fields that one could potentially use for these values are already occupied. Thus one needs to create a FACET OBX and place the additional information into the fields of the facet. The facet indicates that both segments are needed to completely describe the measurement.

### 10.2.2 Hierarchy examples

It is important to recall that a set of OBX segments are scoped by an OBR. Thus the n-tuples within the OBX segments scoped by one OBR bear no semantic relation to the OBX segments scoped by another OBR. Furthermore, as stated in [IHE PCD-01], the only requirement on the values of the n-tuples is "These must create unique n-tuples for each OBX. (That is, each OBX in a set grouped within the scope of an OBR segment must be distinct)." There is also no relation between the OBR sequence number and the MDS n-tuple value as has been incorrectly assumed based on prior versions of the design guidelines. Consequently the MDS-tuple of the first association in OBR|2| does not have to be 2 though it could be.

The set of OBX-4 notations in Figure 10-1 could be written as:

```
|3.0.0.1|
|3.0.0.5|
     |3.0.0.5.6|
     |3.0.0.5.2|
|3.0.0.3|
```

with no loss of semantic information. The relationship between the segments is the same. The following set, on the other hand, would be incorrect if it were to represent the same semantic information as in Figure 10-1.

```
|3.0.0.1|
|3.0.0.5|
|3.0.0.6.6|
     |3.0.0.5.2|
|3.0.0.3|
```

since the OBX segment |3.0.0.6.6| is no longer part of the group scoped by |3.0.0.5|. It also has no parent OBX.

That being said, [IHE PCD-01] recommends that implementers use dictionary ordering (as in Figure 10-1). Dictionary ordering also provides some type of time ordering since new metric instances are usually created as new measurements are received. Readers of the document are also likely to appreciate dictionary ordering.

### 10.2.3 Object hierarchy for compounds

Compound numeric measurements in Continua PCD-01 are not treated as another metric instance. Instead a "channel" tuple is instantiated when a compound numeric is needed. An example would be:

(15 prior metric instances)

```
|1.0.0.16|
|1.0.1|       // First compound metric instance
     |1.0.1.1| // Compound value 1
     |1.0.1.2| // Compound value 2
     |1.0.1.3| // entry from an extra descriptive attribute such as supplemental types
|1.0.0.17|    // Some other non-compound measurement
|1.0.2|       // Second compound instance
     |1.0.2.1|
     |1.0.2.2|.
```

Dictionary ordering cannot be easily maintained with the Continua use of the channel for compounds, but one can keep independent dictionary orderings for the compound and non-compound metrics.

## 10.3 Timestamping

In the Continua use case it is generally assumed that sensors will not have the capability to obtain a good sense of time on their own. They will rely on the ISO/IEEE 11073-20601 SetTime action or the user to set the time, use a simple relative time tick, or provide no timestamp at all. In a local environment these time limitations do not pose a problem. However, data that is sent over the Services-IF can travel around the world making it necessary to provide timestamps that can be unambiguously interpreted regardless of destination.

It is also important that the timestamps provided come from the same unbroken timeline otherwise the differences between any two timestamps would be ambiguous. If all sensors were using Universally Coordinated Time (UTC) that would not be a problem but many sensors only have a sense of local time. Thus if the user resets the sensor clock due to time zone changes, daylight saving time, or clock drift, the timeline is broken. A thirty minute difference may suddenly appear to be ninety minutes. There is no way for the PHG to know about this change without some indication from the sensor. ISO/IEEE 11073-20601 sensors that break their timeline while associated are required to send date-time-adjustment notifications. These date-time-adjustments tell the PHG what to add to the previous timestamps to bring those timestamps up to the sensor's current time line. Sensors that are storing data offline are required to begin storing data in new PM segments on time changes indicating so by adding date-time-adjustment attributes in the affected PM segments. ISO/IEEE 11073-20601 sensors are required to assure a contiguous time line, thus if a sensor time-faults (the continuity of the time line has been lost) the sensor is not to send such data.

There are currently proposals in the ISO/IEEE 11073-20601 working group to allow such data to be sent along with an indicator. The indicator allows the PHG to identify the cases where the timestamps may be both unreliable and non-contiguous. At the moment there is no means to indicate in the PCD-01 document that the timeline is non-contiguous; timelines in PCD-01 are always assumed to be contiguous. To handle these cases some type of indicator will be needed in future versions of the PCD-01 standard.

It should also be pointed out that Continua has temporarily allowed sensors that break time continuity due to resource limitations to be certified. In particular, sensors that store data and change their timelines are allowed to do so without the ISO/IEEE 11073-20601 mandated date-time-adjustments. In this case there is no indication that the sensors are not reporting a contiguous timeline. PHGs handling these sensors that wish not to propagate such data over the Services interface will need to keep a black list of such sensors.

In order to assure unambiguous representation of measurement timestamps in all time zones, Continua requires that PHGs supporting Observation Upload be capable of synchronizing to 'qualified' time. The PHG is to map the sensor time line to this qualified time if necessary. To clarify, 'qualified' time is any time synchronized to UTC with or without knowledge of local time. It is highly recommended that Observation Upload PHGs also be local time aware which comes at minimal additional cost once UTC synchronization is in place. It should also be noted that qualified time by itself does not mean accurate; the accuracy of the qualified time depends upon the synchronization method.

In order for the PHG to be able to map the sensor time line to its UTC time line, Continua requires that if the sensor uses timestamps in any of its measurements that the sensor be able to provide the PHG with its sense of current time. Associated with this requirement is that if sensors store any measurements, they must also provide timestamps which means that all sensors that store data must also be capable of providing a current time. The PHG is then able to compare the sensor's sense of current time with its sense of current time and if necessary, translate the sensors time line to its qualified time line. In PCD-01 language, there is a special *coincident timestamp pair* OBX segment that contains this comparison. With the coincident timestamp pair, even sensors that may default back to some fixed factory programmed initial time upon say a battery change will be able to have their timestamps translated to correct qualified values by a properly synchronized PHG.

With sensors that use absolute time it is not possible for the PHG to unambiguously provide the offset in the time zone that the sensor took the measurement. Even though sensor devices report date-time-adjustments when changing their clocks, the PHG does not know if the adjustment is due to clock skew corrections, daylight savings time changes, time zone changes, or some combination of the previous. However, the reader of the document will be able to obtain the original timestamp sent on the wire to the PHG. With sensors that use base offset time, the PHG will be able to present the time zone of the original measurement, even for those sensors that do not use UTC as the base in their base offset time clocks. In all cases it is assumed that when a sensor associates with a PHG, that the current time reported by the sensor is in the time zone of the PHG. If the sensor has been transported across time zones, it may rely on the user to properly adjust its clock before use. Improper use of a sensor by a user is out of scope of these guidelines.

To address the issue of date-time-adjustments, the [IHE PCD-01] specification requires the creation of a new OBR segment. All OBXes in an OBR segment come from the same unbroken timeline whose time range is delimited by OBR-7 and OBR-8. An alternative solution could have been to adjust the sensor's timestamps by the date-time-adjustment values but there would be no knowledge that adjustments occurred or what the reason for the adjustment was. There is no good solution to the latter problem as long as sensors report only local (absolute) times. The use of the ISO/IEEE 11073-20601 base offset time resolves several of these issues. Changing time zones and daylight savings changes can be reflected in the offset which does not affect the base time. Date-time-adjustments only occur if the base time is, for some reason, changed.

In the Continua use case most sensors are expected to have poorer time capabilities than the PHG and the PHG will translate the sensor time lines to its qualified time line. However, if the sensor happens to support an external means of synchronization to UTC that is more accurate than the PHG's clock one does not Servicest the PHG to translate the sensor's timestamps. In these design guidelines the possibility of superior sensor timestamps is taken into account. The PHG can use the MdsTimeInfo attribute from the sensor to determine who is better synchronized and if the sensor has superior synchronization, the PHG will not translate the times. When more acute care type devices start making their way into the home this case may start to appear.

The next notch upward in sensor sophistication is sensors that can be externally synchronized by the PHG's clock. This capability is out of band with respect to the personal health devices interface. The PHG becomes a time synchronization service and serves as the master clock for the timestamps generated by the sensor, for example using the PHG's Bluetooth clock. In this scenario relative times stamps are typically used where the PHG synchronizes its relative clock to an external NTP source to map the relative times to qualified times. Should this situation apply, these capabilities are reported in the PCD-01 document as noted in the timestamp and time synchronization clause.

### 10.4 The coincident timestamp pair

The coincident timestamp pair MDS-OBX segment contains both the current time of the sensor and the current time of the PHG and allows one to compare the two timelines. If the sensor did not use timestamps at all, these attributes would not be present and there would be no coincident timestamp pair. In versions prior to these design guidelines the PHG always translated and/or corrected the sensor's timestamp in any measurement to its timeline using the coincident timestamp pair if it existed and placed the translated and/or corrected timestamp in the Metric-OBX. If the sensor provided no timestamp in the measurement, the PHG used the time of reception of the measurement in the Metric-OBX.

In these design guidelines the PHG is first required to check the sensor's time synchronization information as returned in the Mds-Time-Info attribute and determine who is better synchronized (see clause D.1.5.3). The key fields in this attribute used to make this determination are:

– the time capability bits (which also report if the sensor is currently synchronized in addition to its capabilities),
– the time synchronization protocol (which reports the protocol used to obtain this synchronization), and
– the time synchronization accuracy.

The rigorous description of the algorithm is given in clause D.1.5.3. If the PHG determines that the sensor is better synchronized, the PHG no longer generates the coincident timestamp pair. The sensor's time capabilities, time synchronization and time synchronization accuracy are reported. When a measurement is received, the sensor's timestamp is used without translation and/or correction but it is formatted to a DTM data type in the Metric-OBX.

If the PHG determines that it is better synchronized than the sensor or the sensor uses one of the relative times, a coincident timestamp pair OBX is required as in the versions prior to these design guidelines. The sensor's time capabilities, time synchronization protocol, and if present the time synchronization accuracy, are also reported. The coincident timestamp pair OBX is created as follows:

OBX-3 contains the MDC code of the sensor's time attribute. It will be either the Date-and-Time, Base-Offset-Time, Relative-Time, or HiRes-Relative-Time attribute. OBX-5 will be the value taken from the attribute formatted as a number if it is one of the relative times and as a DTM timestamp if it is the absolute or base offset time. OBX-2 is then either NM or DTM, accordingly. The PHG's current time is then placed in OBX-14 as a DTM data type regardless of the sensor's time format. In case of the relative times there will also be an OBX-6 entry for the time units and for the relative time value in OBX-5 a conversion of the ISO/IEEE 11073-20601 value to the required units.

The PHG uses the information in the coincident timestamp OBX to take measurement timestamps provided by the sensor and map them to local time plus offset to UTC time (the offset is the hours *added* to UTC time to get local time so EST is −0500) in Metric-OBXes. The coincident timestamp pair also reveals any differences between the sensor's and PHG's notion of current time. If there are any differences, the PHG notes that difference and applies it to subsequent measurement times stamps received from the sensor. Thus if the sensor clock is noted to be 20 seconds behind the PHG's clock, the PHG will add that 20 seconds to the timestamps in all subsequent Metric OBXes. The coincident timestamp pair also allows one to recreate the original sensor timestamps for auditing purposes; for example in the above case by subtracting 20 seconds from each of the corrected timestamps one will obtain the sensor's timestamp as sent on the wire.

In the case of relative times, the PHG uses the coincident timestamp pair to establish the '0' point on the time axis. If the sensor uses relative time (units are 1/8 ms) it might report a current relative time of 14905355. The PHG notes its current time is January 3rd, 2014, 10:14:40 EST. The PHG then receives a scan event report and the relative time is 14105355. The difference is −800000 which means the measurement was actually taken 100 seconds earlier (this scan event report must have been a temporarily stored measurement). The PHG would then subtract 100 seconds from its time reported in OBX-14 of the coincident timestamp pair OBX and place that result in OBX-14 of the Metric-OBX.

If the PHG receives a measurement that contains no timestamp, the PHG places the time of reception of the measurement into OBX-14 of the Metric-OBX as was done in the versions prior to this version of the guidelines. Furthermore, if the sensor does not use timestamps in any of its measurements, [ISO/IEEE 11073-20601] does not require that the sensor report current time or MdsTimeInfo in its MDS. In that case there will be no coincident timestamp pair in the MDS-OBXes and no time capabilities or time synchronization information.

### 10.5 PHG-OBXes

PHG-OBX segments are unique to Continua. They are created once per PCD-01 document and are placed under the first OBR. The first PHG-OBX segment that occurs is called the top-level OBX and appears as follows:

```
OBX|1||531981^MDC_MOC_VMS_MDS_PHG^MDC|0||||||X|||||||0000ABEEDEADBEEF^^0000ABEEDEADBEEF^EUI-
64
```

Every field in this OBX is the same for all PHGs except OBX-18 which is the PHG's system Id as an EI-data type. The EI data type has four components and the use of these components depends upon whether the identifier being used is 'local' or universal. [ISO/IEEE 11073-20601] system ids are encoded using the EUI-64 profile which is a universal identifier type. Thus, the universal id type component EI-4 is used instead of the local identifier EI-2. EI-4 is always `EUI-64`. The system id is the universal identifier which is in EI-3 and if a EUI-64 type, EI-3 is always encoded as a HEX sequence with 16 HEX digits without the 0x prefix commonly used in programming languages. Leading zeros are filled in if needed. EI-1 is a unique identifier of some type and for Continua PHGs and sensors expressing the system Id, EI-1 may have the same value as EI-3 in the same format. In other contexts where the identifier is not universal, EI-1 and EI-2 are used.

The hierarchy in OBX-4 uses the special MDS tuple-value of '0' to indicate that this OBX segment represents the PHG. The single '0' indicates that it is the top-level OBX. It is standard practice to drop trailing zeroes in the hierarchy notation. `|0|` is short for `|0.0.0.0.0.0|`.

OBX-11 is used to represent the status of the measurement. Following [IHE PCD-01] which states "The value of X is used for device related segments where OBX-7 is not used to express the device measurement range capability", one would think that all PHG and MDS OBX segments would have

OBX-11 to set X (measurement not obtainable). However, in [IHE PCD-01] the only device-related segments that appear are what Continua refers to as top-level segments. These special segments have no OBX-2 or OBX-5. What is not considered in [IHE PCD-01] is the case where device information is reported in OBX-5, such as battery level, serial number and current time. Though these OBX segments are clearly device-related, the [IHE PCD-01] specification makes no provision for this case; the specification states that if OBX-11 is set to X it indicates an OBX-5 of null. To be most compatible with the PCD guidelines, device-related OBX segments with non-null OBX-5 values set OBX-11 to R (non-validated measurement received).

The remaining PHG-OBX segments contain certification, regulatory information and time synchronization information. To create these OBX segments the PHG is treated as if it had an [ISO/IEEE 11073-20601] MDS object with a Reg-Cert-Data-List and Mds-Time-Info attribute.

The Continua regulatory information is encoded as follows:

```
OBX|n|CWE|68218^MDC_REG_CERT_DATA_AUTH_BODY^MDC|0.0.0.x|2^auth-body-continua||||||R
OBX|n+1|ST|532352^MDC_REG_CERT_DATA_CONTINUA_VERSION^MDC|0.0.0.x.1|4.0||||||R
OBX|n+2|NM|532353^MDC_REG_CERT_DATA_CONTINUA_CERT_DEV_LIST^MDC|0.0.0.x.2|16391~8199||||||R
OBX|n+3|CWE|68218^MDC_REG_CERT_DATA_AUTH_BODY^MDC|0.0.0.x+1|2^auth-body-continua||||||R
OBX|n+4|CWE|532354^MDC_REG_CERT_DATA_CONTINUA_REG_STATUS^MDC|0.0.0.x+1.1|1^unregulated-
device(0)||||||R
OBX|n+5|CWE|68218^MDC_REG_CERT_DATA_AUTH_BODY^MDC|0.0.0.x+2|2^auth-body-continua||||||R
OBX|n+6|CWE|532355^MDC_REG_CERT_DATA_CONTINUA_PHG_CERT_LIST^MDC|0.0.0.x+2.1|0^observation-
upload-soap~2^capability-exchange||||||R
```

where the '*n*' in the sequence number indicates there are *n*-1 OBX segments prior to the first one in this group and the '*x*' in OBX-4 indicates that there are *x*-1 metric instances before the first one in this group (some instances may have facets so *x* and *n* may not be the same).

Only the **bold** OBX-5 fields are dependent upon a given PHG. The MDC codes in OBX-3 are special to the services and are not seen in [ISO/IEEE 11073-20601] exchanges. Encoding the values requires understanding the ASN-1 structure Continua has assigned to the Reg-Cert-Data-List attribute. This structure is defined in clause 6.3.2.6 "*X73 component – Regulatory settings*" of [ITU-T H.811].

In short:

– OBX|n+1| contains the Continua major and minor version number in OBX-5.

– OBX|n+2| contains the list of Continua defined codes representing the sensor specializations and transports that the PHG has been certified for in OBX-5.

– OBX|n+4| contains the regulation status BITs settings in OBX-5.

– OBX|n+6| contains the Continua defined codes for the health and fitness service classes that the PHG has been certified for in OBX-5.

The other required PHG-OBX entry that must occur in every PCD-01 document is the time synchronization used. For example

```
OBX|n|CWE|68220^MDC_TIME_SYNC_PROTOCOL^MDC|0.0.0.x|532224^MDC_TIME_SYNC_EBWW^MDC||||||R
```

The reporting of relative times is only of interest when the PHG and sensor synchronize their relative times. There are currently no Continua devices on the market that fall into this use case.

## 10.6 MDS-OBXes

The MDS-OBXes are populated from a subset of the attributes on the sensor's medical device system (MDS) object. Only the following attributes are encoded into OBX segments:

**Table 10-1 – MDS-OBX attributes**

| Attribute | Ref Id | Requirement |
|---|---|---|
| System-Type | MDC_ATTR_SYS_TYPE | Required if valued (Note 1) |
| System-Model | MDC_ATTR_ID_MODEL | Required |
| System-Id | MDC_ATTR_SYS_ID | Required |
| Production-Specification | MDC_ATTR_ID_PROD_SPECN | Required if valued |
| Mds-Time-Info | MDC_ATTR_MDS_TIME_INFO | Some elements required if valued |
| Date-and-Time (Note 2) | MDC_ATTR_TIME_ABS | Required if PHG is better synchronized than sensor |
| Relative-Time (Note 2) | MDC_ATTR_TIME_REL | Required if valued |
| HiRes-Relative-Time (Note 2) | MDC_ATTR_TIME_REL_HI_RES | Required if valued |
| Base-Offset-Time (Note 2) | MDC_ATTR_TIME_BO | Required if PHG is better synchronized than sensor |
| Power-Status | MDC_ATTR_POWER_STAT | Optional |
| Battery-Level | MDC_ATTR_VAL_BATT_CHARGE | Optional |
| Remaining-Battery-Time | MDC_ATTR_TIME_BATT_REMAIN | Optional |
| Reg-Cert-Data-List | MDC_ATTR_REG_CERT_DATA_LIST | Required if valued |
| System-Type-Spec-List | MDC_ATTR_SYS_TYPE_SPEC_LIST | Required if valued. |
| Tick-Resolution | MDC_TICK_RESOLUTION | Required if valued |
| NOTE 1 – This will not occur with Continua specializations since the System-Type-Spec-List is required and only one of System-Type-Spec-List or System-Type is allowed by [ISO/IEEE 11073-20601]. NOTE 2 – This will result in a coincident timestamp OBX. | | |

There is also a top-level MDS-OBX. Its OBX-4 field is |*x*| where *x* is typically 1. An example follows:

```
OBX|n||528404^MDC_DEV_SPEC_PROFILE_BCA^MDC|1|||||||X|||||||0022D6014AFBD418^^0022D6014AFBD418^
EUI-64
```

where the sequence number n depends upon where in the list of OBX segments this segment is placed. The sensor's system id is placed in OBX-18 as an EI data type and the MDC code for the sensor specialization is placed in OBX-3 as a CWE data type. In the above example the sensor is a body composition analyser. The specialization comes from the System-Type-Spec-List. If there is more than one specialization indicated in the System-Type-Spec-List, the top-level OBX-3 entry contains the special profile 'hydra' which indicates multiple specializations. In that case an extra MDS-OBX is needed that contains the System-Type-Spec-List entries as repeated CWE data types.

```
OBX|n||528384^MDC_DEV_SPEC_PROFILE_HYDRA^MDC|1|||||||X|||||||0022D6014AFBD418^^0022D6014AFBD41
8^EUI-64
OBX|n+1||68186^MDC_ATTR_SYS_TYPE_SPEC_LIST^MDC|1.0.0.1|528404^MDC_DEV_SPEC_PROFILE_BCA^MDC~528
388^MDC_DEV_SPEC_PROFILE_PULS_OXIM^MDC||||||R
```

## 10.7 Metric OBXes

Metric OBX segments represent measurements. The [ISO/IEEE 11073-20601] engine of the PHG creates measurements from 'scan event reports' or 'segment data events'. Scan event reports contain 'observation scans' or 'group observation scans', the latter of which is an efficient formatting of a set of observation scans. Segment data events contain 'entries' which contain 'elements' where the elements are semantically an observation scan. The bottom line is that an observation scan contains a list of attributes that are updated on an object plus the handle to that object. If the handle to that object is a metric object AND at least one of the updated attributes is an observational attribute, the update is a measurement. The PHG's [ISO/IEEE 11073-20601] engine takes the updated attributes and combines them with the contextual attributes for the updated object and creates the final measurement that is dispatched to the user of those measurements. It is the job of the PHG to maintain the contextual attributes and to filter out all 11073-specific maintenance operations. An example of a maintenance operation would be weighing scales switching from kilograms to pounds. The Bluetooth low energy (Bluetooth LE) engine of the PHG would create similarly mapped metric measurement objects from the Bluetooth LE attributes.

The task of the PCD-01 translator is to take that 'final' measurement and create Metric OBX segments from it. The primary work is then to map the observational attributes of the three classes of metric objects into OBX-5.

### 10.7.1 Mapping the 11073 observational attributes in OBX-5 and data type in OBX-2

In [ISO/IEEE 11073-20601] the coding of OBX-5 from the received measurement is the most dynamic. The schematic below summarizes the translations:

Numerics have the following cases:

1. Basic-Nu-Observed-Val and Simple-Nu-Observed-Val use the NM data type.
2. The Nu-Obs-Value case also uses the NM data type but the PCD-01 translator must process the state, unit-code and metric-Id substructures that are packaged with it. These substructures mirror the Measurement-Status, Unit-Code and Metric-Id attributes.
3. Compound versions of the above also use the NM data type but an OBX is created for each compound entry and the OBX-3 value is taken from the Metric-Id-List attribute instead of the TYPE or Metric-Id attribute. There is also the Continua mapping of the parent OBX to the 11073-10201 channel.
4. Compound-Nu-Observed-Val attributes use the NM data type but use the state, unit-code and metric-Id substructures contained within the attribute instead of the context attributes in the object.

Enumerations have three possible data types:

1. ASN-1 BITS fields are encoded as a CWE type similar to MDC codes where the first component is the bit value (0 or 1) and the second component is the normative ASN-1 name and bit number in parentheses. The third component is empty and not present. If more than one bit is set, the component is repeated. For example:

   a) 1^ device-battery-low(0)

   b) 1^(0)

   c) 1^ device-battery-low(0)~1^sensor-read-interrupt(9)

   d) 1^ (0)~1^ (9)

   In cases a) and c) the name is known and in cases b) and d) it is not. Cases c) and d) represent more than one bit setting.

   Typically cleared bits (bit is zero) are not sent though it is legal to do so.

2. OID-enums in [ISO/IEEE 11073-20601] are MDC codes and are encoded as CWE data types exactly like OBX-3.
3. String-enums are encoded as ST data types which means 'string'.

RTSAs are semantically a sequence or list of complete measurements in time order. However, to represent this measurement the HL7 NA (numeric array) data type is used as a one dimensional vector. This choice is to be consistent with PCD. The one dimensional vector is represented by numerical entries separated by the component separator which in the standard interpretation of component separators indicates that all the components together are needed to describe the measurement. Semantically the interpretation is inconsistent with an RTSA sequence since each entry in the RTSA is an independent measurement in time and one would expect the separator to be the repetition symbol. The implementer needs to be aware of the chosen convention (NOTE). OBX-5 then consists of a sequence of numbers separated by the component separator symbol (^).

NOTE – In the future this representation may change as multi-dimensional waveforms such as the acceleration vector are being considered by PCD.

On the wire RTSA data is scaled into 8, 16 or 32 bit integers to take less space. Support attributes in the RTSA object contain the scaling factors. When populating the OBX-5 field, the on-the-wire values are rescaled to their original values using the support attributes.

### 10.8 Date-Time-Adjustment

The date-time-adjustment occurs when the sensor's clock is changed while it is recording or storing measurements. It is most likely to occur on sensors using absolute time when changing time zones or due to daylight savings time but it can also happen when adjusting clock skew. On sensors reporting base-offset time date-time-adjustments only occur if the base time is, for some reason, altered.

The value of the date-time-adjustment is the time one needs to add to any previous measurement times to bring the timestamps of those measurements to the current sensor timeline. In PCD-01 a date-time-adjustment is handled by generating a new OBR and restarting the process as if it were a new association. The new OBR will need a new set of MDS-OBXes. The PHG-OBXes do not need to be regenerated.

The date-time-adjustments can also be present in an attribute of a PM segment. Each segment containing a date-time-adjustment that is different requires a new OBR.

[ISO/IEEE 11073-20601] also states that 'small' adjustments do not need to be reported by the sensor. However, what is meant by small is not defined.

## 11 Guidelines

The locations of the guidelines for creating the PCD-01 document are specified in this clause. The requirements for the MSH, PID and OBR segments are fairly straight forward.

### 11.1 MSH

The guidelines for creating a Continua compliant MSH segment are in clause E.4.1.

### 11.2 PID

The guidelines for creating a Continua compliant PID segment are in clause E.4.2.

### 11.3 OBR

The guidelines for creating a Continua compliant OBR segment are in clause E.4.3.

### 11.4 OBX

The guidelines for generating the OBX segments consist of several parts.

The basic guidelines are in clause E.4.4 and should be examined first.

The remaining guidelines are in clause D.1 where:

- The guidelines for formulating the PHG OBXes are in clause D.1.1.
  - There are no attributes on a PHG. 'Fake' attributes that mirror the MDS attributes on a sensor map to one of more OBX segments.
- The guidelines for formulating the MDS OBXes are in clause D.1.2.
  - In general attributes from the sensor's MDS object map to one or more OBX segments.
- The guidelines for formulating the Metric OBXes are in clause D.1.3.
  - In general *several* attributes from the sensor's metric object map to *one* OBX segment.
    - TYPE or Metric-Id determines OBX-3
    - Observational attribute determines OBX-2 and OBX-5
    - Unit code determines OBX-6
    - Measurement status determines OBX-8/OBX-11
    - Timestamp determines OBX-14
  - Metric objects with compound attributes will map to at least a channel OBX segment and one child OBX segment for each compound entry.
  - Some metric attributes, if present, result in an extra OBX segment to describe the properties of the attribute. These segments are children.
- Special conditions are covered in clause D.1.4
  - Date-Time-Adjustments
  - OBX-20 replacing OBX-5
  - Separating stored and live measurements
  - Measurements with and without timestamps in same association
  - Multiple devices
  - Set Time action
  - Bluetooth low energy

# Annex A

## Normative guidelines for common aspects

(This annex forms an integral part of this Recommendation.)

**Table A.1 – Guidelines for all CCC classes**

| Name | Description | Comments |
|---|---|---|
| Services-Transport-Connection-Initiation | All Continua services connections **shall** be initiated from the PHG application and **shall not** be initiated from the services application | |

**Table A.2 – Observation Upload guidelines for an PHG application**

| Name | Description | Comments |
|---|---|---|
| Services-Messaging-Device-Observation-Reporter | Continua PHG applications **shall** implement the device observation reporter actor of the IHE PCD device enterprise communication (DEC) profile | |

**Table A.3 – Observation Upload guidelines for a services application**

| Name | Description | Comments |
|---|---|---|
| Services-Messaging-Device-Observation-Consumer | Continua services applications **shall** implement the device observation consumer actor of the IHE PCD device enterprise communication (DEC) profile | |

# Annex B

## Normative guidelines for hData

(This annex forms an integral part of this Recommendation.)

**Table B.1 – Observation Upload guidelines for an PHG application using hData**

| Name | Description | Comments |
|---|---|---|
| Observation-Upload-Enabled-PHG | Observation Upload enabled PHG application shall comply to the following standards:<br>[HL7 V3 HRF] Specification: hData Record Format, Release 1<br>[OMG/hData REST] Binding for RLUS<br>[OMG/hData RLUS] Retrieve, locate and update service (RLUS) | |
| Observation-Upload-PHG-Capability-Exchange | A PHG application supporting Observation Upload using hData shall support capability exchange as specified in [ITU-T H.812.3] | |
| Observation-Upload-PHG-Root-Support | A PHG application that chooses to POST a root.xml file to a services application during capability exchange shall provide the profile element in the root.xml in accordance with Figure 7-2. | |
| Observation-Upload-Post | Observation Upload enabled PHG application shall use HTTP POST with the URL for posting to the services application as specified in the <path> element of the capability profile elements:<br>baseURL/path-as-specified-in-capability-profile for uploading the PCD-01 payload. | For RLUS hData over REST transport, this upload is accomplished by performing an HTTP POST request without query parameters at this URL with the observation measurement document in the body of the request |

**Table B.2 – Observation Upload guidelines for a services application using hData**

| Name | Description | Comments |
|---|---|---|
| Observation-Upload-Enabled-Services | Observation Upload enabled services application shall comply to the following standards:<br>– [HL7 V3 HRF] Version 3 Specification: hData Record Format, Release 1<br>– [OMG/hData RESTful Trans] Binding for RLUS<br>– [OMG/hData RLUS] Retrieve, locate, and update service (RLUS)<br>– [IHE PCD-01] for PCD-01 document | |
| Observation-Upload-Services-Capability-Exchange | A services application supporting Observation Upload using hData shall support capability exchange as specified in [ITU-T H.812.3] | |
| Observation-Upload-Services-Root-Support | A services application supporting Observation Upload shall provide a root.xml file during capability exchange with profile elements in the root.xml in accordance with Figure 7-2. | |
| Observation-Upload-Services-OAuth-Service | A services application supporting an OAuth authentication service may indicate support for the service in its root.xml. If the service chooses to add these capability elements, they shall appear as in Figure 7-3. | |
| Observation-Upload-Services-Document-Create | Observation Upload enabled services application shall create a PCD-01 document after receiving POST message from the Observation Upload enabled PHG application and send the <HTTP 201> as a response. | |
| Observation-Upload-Services-Document-Delete | Observation Upload enabled services application shall not support the deletion of an existing PCD-01 document and shall return HTTP 405 Method Not Allowed as a response to HTTP DELETE request on an Observation Upload URL. | |

# Annex C

## Normative guidelines for SOAP

(This annex forms an integral part of this Recommendation.)

**Table C.1 – Common Observation Upload guidelines using SOAP**

| Name | Description | Comments |
|---|---|---|
| Services-Messaging-Infrastructure-Profile-IHE | Continua PHG and services applications **shall** conform to Appendix V of [IHE ITI-TF-2] | Base transport standard |
| Services-Secure-Auditing | Continua services application and client components **may** implement and adhere to the IHE ATNA auditing related clauses (clause 3.20, in Part A of [IHE PCD TF 2012 2]) | Profiles referenced by IHE ATNA for auditing:<br>The BSD (Berkeley Software Distribution) Syslog Protocol [IETF RFC 3164];<br>Reliable Delivery for Syslog [IETF RFC 3195];<br>Security Audit and Access Accountability Message XML Data Definitions for Healthcare Applications [IETF RFC 3881] |
| Services-Security-Assertion | Continua services application and client components **shall** support the transfer of entity assertion information via the SAML 2.0 token through the WS-Security Header according to the Web Services Security: SAML Token Profile 1.1 | IHE Cross Enterprise User Assertion (XUA) profile uses the same mechanisms for the cross enterprise authentication of users.<br>The profile does not prohibit the use of other types of tokens (certificates) for an entity, providing that interoperability is being assured through some policy negotiation in an online or out-of-band fashion |
| Observation-Upload-Capability-Exchange | Continua services application and client components supporting only SOAP uploads **may** support capability exchange as indicated in [ITU-T H.812.3] | This feature allows a PHG to configure Observation Uploads with fewer out-of-band exchanges. |
| Observation-Upload-Root-Support | Continua services application and client components supporting only SOAP uploads **may** include capability elements in the root.xml indicating support for SOAP based uploads. If the capability elements are included, they **shall** be as shown in Figure 7-4 | If the SOAP only upload application chooses to support capability exchange, it must follow the same rules as hData based upload applications. That means a PHG application wishing to POST its root.xml must provide an OAuth token in the POST. |
| Services-Transport-QoS-Reliability-Better | Continua PHG and Services applications **may** transmit messages from the Continua *better* QoS bin using a WS-ReliableMessaging sequence configured to use 'AtMostOnce' message delivery | WS-Reliable messaging |
| Services-Transport-QoS-Reliability-Best | Continua PHG and services applications **should** transmit messages from the Continua *best* QoS bin using a WS-ReliableMessaging sequence configured to use 'ExactlyOnce' message delivery | WS-Reliable messaging |

**Table C.2 – Observation Upload guidelines for an PHG using SOAP**

| Name | Description | Comments |
|---|---|---|
| Services-Messaging-Infrastructure-Reliable-Messaging-Sender-Observations | A Continua PHG application **may** support WS-ReliableMessaging as an RM source for CommunicatePCDData messages | Note that WS-Reliable messaging is SOAP based |

**Table C.3 – Observation Upload guidelines for a health and fitness service using SOAP**

| Name | Description | Comments |
|---|---|---|
| Observation-Upload-SAML-Token-Root-Support | A Continua services application supporting an SAML token WS-Trust service **may** include capability elements in the root.xml indicating support for this service. If the capability elements are included, they shall be as shown in the script of Figure 7-5 | This feature is allowed to reduce the number of out-of-band transactions needed to configure the client for SOAP based Observation Uploads. |
| Services-Messaging-Infrastructure-Reliable-Messaging-Receiver-Observation-Reception | A Continua services application supporting SOAP uploads **shall** support WS-ReliableMessaging as an RM destination for CommunicatePCDDataResponse messages | This requirement applies only to Continua services service components supporting SOAP Observation Uploads. |
| Services-Messaging-Infrastructure-Reliable-Messaging-Receiver-Observation-Response-Transmission | A Continua services application supporting SOAP uploads **shall** support WS-ReliableMessaging as an RM source for CommunicatePCDDataResponse messages | An RM sequence shall only be used if the services sender has provided an RM "Offer" for the services receiver to use |

# Annex D

## Normative guidelines data payload

(This annex forms an integral part of this Recommendation.)

This annex gives the general guidelines for creating the PCD-01 payload. Table D.1 provides guidelines of a broad scope. The following subclauses provide the details for mapping ISO/IEEE 11073-20601 data to the Continua services.

**Table D.1 – Observation Upload general data payload guidelines**

| Name | Description | Comments |
|---|---|---|
| Services-Data-Standard | Continua PHG and services applications **shall** conform to the IHE PCD TF Patient Care Devices Technical Framework Revision 2.0 except where these constraints conflict with this document | There are no known conflicts |
| Services-Data-Standard-Constraints | Continua PHG and services applications [HL7 2.6] message payloads **shall** conform to the constraints defined in [IHE PCD TF-2] | Annex F is the reference |
| Services-Data-Standard-Encoding | Continua PHG and services applications **shall** use the HL7 2.6 EDI encoding and **shall not** use the HL7 2.6 XML encoding [HL7 2.6] | The PCD TF allows both EDI and XML encoding |
| Services-Data-Coding-MDC | Continua PHG application observations **shall** use the medical device communication (MDC) coding system for all observation identifiers (OBX-3, OBX-20) | Minimal translation |
| Services-Data-Measurement-Units | Continua PHG application observations **shall** use the medical device communication (MDC) coding system for all non-empty units (OBX-6) | Minimal translation |
| Services-Data-Minimize-Convention | Continua PHG applications **should** terminate all Observation Result segments after their last non-empty sequence | |
| Services-Authoring-MSH | The Continua PHG application **shall** generate the MSH segment according to the guidelines specified in clause E.4.1 | |
| Services-Authoring-PID | The Continua PHG application **shall** generate the PID segment according to the guidelines specified in clause E.4.2 | |
| Services-Authoring-OBR | The Continua PHG application **shall** generate the OBR segment according to the guidelines specified in clause E.4.3 | |

**Table D.1 – Observation Upload general data payload guidelines**

| Name | Description | Comments |
|---|---|---|
| Services-Data-Client-Device | The PHG application **shall** provide regulatory and time information in a set of PHG-OBX segments according to clause D.1.1 | Clause D.1.1 provides the detailed guidelines for creating the PHG-OBX segments. These segments expose the identity, regulatory information and time capabilities of the PHG client. |
| Services-Data-Authoring-Device | For observations which originate from a Continua personal health device, the Continua PHG application **shall** include MDS-level OBX segments according to clause D.1.2 | Clause D.1.2 provides the detailed guidelines for creating the MDS-OBX segments. These segments expose the device type, identity, regulatory information and time capabilities. |
| Services-Data-Authoring-Device-Encoding-Algorithm | For observations which originate from an [ISO/IEEE 11073-20601] compliant device or that can be mapped to a set of observations as if they came from an [ISO/IEEE 11073-20601] compliant device, the Continua PHG application shall encode the observations into Metric OBX segments according to clauses D.1.3 and D.1.4 | These annexes provide the mappings of observations into OBX segments |
| Services-Data-Authoring-Device-Encoding-Containment | For observations which originate from a Continua personal health device, the Continua PHG application **shall** use the specified containment notation in OBX-4 | Maintain relationships of measurements |
| Services-Data-Authoring-Device-Encoding-Timestamp | The Continua PHG application **shall** report all time values in MSH-7, OBR-7, OBR-8 and OBX-14 as UTC or UTC coordinated values expressed as an HL7 date/time (DTM) data type | It is imperative that all measurements can be correlated to a single comprehensive timeline for proper, safe analysis and usage.<br>UTC values are reported using the +/−ZZZZ time zone suffix. If the local time zone is not known −0000 is used.<br>Under special conditions the PHG may fall back to sending unqualified timestamps. |
| Services-Data-Authoring-Device-Encoding-Nomenclature-Translation | Continua PHG applications **shall** adjust all nomenclature values that use the "_X" indicator in the name to the corresponding correct base value without the "_X" indicator. | Ensure all nomenclature usage is aligned.<br>This form of the unit code REFID values is called "unity scaling" because there is no SI prefix used |

### D.0 Mapping from [ISO/IEEE 11073-20601]to the Continua services

#### D.0.1 Terminologies and conventions

The following clause provides guidelines for mapping [ISO/IEEE 11073-20601] attributes and objects into OBX segments. The guidelines require the use of ASN.1 terminologies and PCD-01 terminologies. To distinguish the terminologies, the prefix "ASN.1-" will appear before names referencing [ISO/IEEE 11073-20601] ASN.1 attribute structures and substructures if the name is not specifically stated to be an attribute or ASN.1 structure. Attribute names are capitalized and separated by dashes, for example Relative-Time. ASN.1 substructures within attributes are lower case and separated by dashes, for example, ASN.1-component-id. References to the ASN.1 names and attributes are found in [ISO/IEEE 11073-20601] and related specialization standards. The words 'component', 'sub-component' and 'field' refer to the PCD-01 usages of these terms.

To the extent possible, the term 'observation' is used in the guidelines to represent a physiological measurement instead of 'measurement'.

Handling Bluetooth low energy (LE) attributes is done by semantically mapping the BTLE attributes to [ISO/IEEE 11073-20601] attributes and using the guidelines provided in this document to generate the PCD-01 document payload. The Transcoding White Paper [Bluetooth PHDT] provides the mapping.

**PHG-OBX** segments describe the properties of the PHG. Though it may appear that these segments are derived from an [ISO/IEEE 11073-2060] MDS object on the PHG, there is no requirement for the PHG to possess this object or its attributes.

**MDS-OBX** segments describe properties of the sensor. These segments are generated from a subset of the attributes in the sensor's [ISO/IEEE 11073-20601] MDS object. The [ISO/IEEE 11073-20601] personal health devices engine of the PHG obtains these attributes using the [ISO/IEEE 11073-20601] GET request. The Bluetooth low energy PAN engine of the PHG obtains equivalent values for these [ISO/IEEE 11073-20601] attributes from the sensor's device information service and whatever current time mechanism the device supports. The Transcoding White Paper [Bluetooth PHDT] provides the mapping.

**Metric-OBX** segments describe observations. Observations are represented in [ISO/IEEE 11073-20601] metric objects. The [ISO/IEEE 11073-20601] personal health devices engine of the PHG receives observation updates via [ISO/IEEE 11073-20601] scan event reports or segment data events whose ASN.1-observation-scans contain at least one metric value-type *observational* attribute (see NOTES). The update is combined with contextual information maintained by the PHG and the resultant metric object (the observation) is mapped to one or more Metric OBX segments. The Bluetooth low energy PAN engine of the personal health gateway (PHG) maps the GATT attributes received via indications or notifications to equivalent [ISO/IEEE 11073-20601] metric objects which are then mapped to one or more Metric OBX segments. The Transcoding White Paper [Bluetooth PHDT] provides the mapping.

NOTE 1 – [ISO/IEEE 11073-20601] also allows updates of MDS attributes via scan event reports such as the battery level. Though they do not represent physiological observations the reporting of this information may be of interest and it is left up to the implementer whether or not to include them in the PCD-01 document.

NOTE 2 – Segment data events transfer PM segment data but each entry element maps to a metric object and it is the metric object that represents the observation. Thus, all observations are ultimately from one of the sensor's metric objects regardless of whether they use the PM Store/PM Segment, Scanner or Agent-init models to transfer the data.

#### D.0.2 Protocol-dependent information

[ISO/IEEE 11073-20601] defines concepts whose sole purpose is to aid in the exchange of APDUs so that the data in the APDUs can be reconstructed into measurements. The PM Store, PM Segment, Scanner, AttributeValue Map, scan event report formats (fixed, variable, group), object handles and config ids are all examples of these concepts. These items are not reported in the PCD-01 document. One will note that the Bluetooth low energy transcoding white paper [Bluetooth PHDT] is also careful to only map Bluetooth LE features to ISO/IEEE 11073-20601 features that are important for sensor properties and measurements. There is no mapping, for example, of the Bluetooth LE RACP to PM stores and PM segments or Bluetooth LE characteristic descriptors to ISO/IEEE 11073-20601 attributes since these items are all aids in the protocol transfer of information and not the information itself.

### D.0.3 Services-specific nomenclature

Additional nomenclature codes not defined in [ISO/IEEE 11073-20601] are defined by Continua for the PHG- and MDS-OBX segments. These codes are needed as several of the MDS attributes contain multiple ASN.1 substructures, where each substructure requires an OBX segment and thus an OBX-3 key word in order to describe the information. These codes are also used in the PHG-OBX segments to represent analogous information. Table D.2 lists these new codes.

**Table D.2 – Continua services regulation nomenclature codes**

| Partition | Nomenclature code's common name | Code |
|---|---|---|
| MDC_PART_OBJ | MDC_REG_CERT_DATA_AUTH_BODY | 2682 |
| MDC_PART_INFRA | MDC_MOC_VMS_MDS_PHG | 7693 |
| MDC_PART_INFRA | MDC_REG_CERT_DATA_CONTINUA_VERSION | 8064 |
| MDC_PART_INFRA | MDC_REG_CERT_DATA_CONTINUA_CERT_DEV_LIST | 8065 |
| MDC_PART_INFRA | MDC_REG_CERT_DATA_CONTINUA_REG_STATUS | 8066 |
| MDC_PART_INFRA | MDC_REG_CERT_DATA_CONTINUA_PHG_CERT_LIST | 8067 |

### D.0.4 ISO/IEEE 11073-20601 general object/attribute mapping

This clause provides detailed guidelines for the mapping of ISO/IEEE 11073-20601 objects and attributes to OBX segments. Only a subset of the ISO/IEEE 11073-20601 objects and attributes are used in this mapping. The guidelines in this annex apply to any sensor whose information and/or observations are mapped to ISO/IEEE 11073-20601 objects and attributes whether or not they are [ISO/IEEE 11073-20601] sensors. An example would be Bluetooth low energy sensors whose transactions have been mapped to the necessary ISO/IEEE 11073-20601 objects and attributes in the Transcoding White Paper [Bluetooth PHDT].

#### D.0.4.1 Nomenclature code mapping

The mapping of [ISO/IEEE 11073-20601] to PCD-01 is primarily through nomenclature codes. In PCD-01 these codes are mapped into an HL7 CWE data type. This encoding occurs so frequently it is worth indicating in detail how the encoding is done.

**CWE encoding for nomenclature codes:**

A nomenclature code is always associated with a partition. In some attributes that only give a nomenclature code the partition is implicit; for example the Unit-Code attribute value always comes from partition 4 (MDC_PART_DIM). In other cases the partition is obtained from either the TYPE attribute value's partition or from the presence of an attribute like the Metric-Id-Partition or Enum-Observed-Value-Partition that contains the partition.

– CWE-1 **shall** contain the code. It is computed by (partition code) * $2^{16}$ + (nomenclature code) and always presented as a decimal number (not HEX). This component is required.

– CWE-2 **should** contain the nomenclatures code's reference Id name. This component may be empty if the reference id name is not known, but all efforts should be made to include this name as it makes the subsequent document much more human readable. Note that OBX-3 in Continua PCD-01 documents is *always* an encoded nomenclature code and without the name the reader will need to look up the associated name given CWE-1.

– CWE-3 **shall** be MDC

– CWE-4 is empty

– CWE-5 is an alternate text component that is used to describe extra information. If the sensor includes one of the label string attributes it is placed here.

The above requirements differ slightly from that of HL7 which require that CWE-2 be non-empty and allow all the other components to be empty.

Example: Weighing scales containing a body mass object. The TYPE attribute value for this object gives the partition value, which is 2, and the nomenclature code, which is 57664.The reference id for code 57664 in partition 2 (scada) is MDC_MASS_BODY_ACTUAL. The reference Id as a string must be looked up; it is not present on the wire in an ISO/IEEE 11073-20601 transaction. Thus the encoded value for CWE-1 is $2*2^{16} + 57664 = 188736$. Note that in HEX the value is 0x0002E140. The partition is the most significant two bytes and the nomenclature the least significant two bytes. The final CWE encoding is:

```
188736^MDC_MASS_BODY_ACTUAL^MDC
```

Without the optional CWE-2 name component, it is "`188736^^MDC`", which is not as easy for a reader to interpret.

### D.0.4.2 ASN.1 BITS mapping

Though not as ubiquitous as nomenclature codes, the mapping of an [ISO/IEEE 11073-20601] ASN.1-BITs field to a PCD-01 HL7 CWE data type is also discussed in detail as it can be confusing.

***CWE encoding for ASN.1 BITS values:***

ASN.1 BITS values are commonly used for flags; for example reporting equipment status, measurement status, time capabilities, etc. In this case only two components of the CWE data type are used; CWE-3 is empty and thus not included in the OBX field. Each bit setting is represented by its own CWE entry. The entries are separated by the repetition symbol (~). However, Continua only requires the entry if the bit is set (1). If the bit is cleared (0), including the entry is optional. Thus for a given bit:

– CWE-1 **shall** be the bit setting. It is either 1 or 0.
  - o If the bit is set, the entry **shall** be present
  - o If the bit is cleared, the entry **may** be present.

– CWE-2 is the ASN.1 name for this bit which contains the bit position in parentheses appended to the end of the ASN.1 name, for example `mds-time-capab-bo-time(7)`. If the ASN.1 name is not known the name string **may** be absent but the bit position in parentheses **shall** be present, for example `(7)`.

Example: The Mds-Time-Info attribute's time-capabilities are an ASN.1-BITS-16 struct. A sensor indicates that its time capabilities value is as follows: 0100000100010010. Recall that bit 0 is the most significant bit in MDER encoding. From the ASN.1 table for the time capability bits one has

– `mds-time-capab-real-time-clock(0)`
– `mds-time-capab-set-clock(1)`
– `mds-time-capab-relative-time(2)`
– `mds-time-capab-high-res-relative-time(3)`
– `mds-time-capab-sync-abs-time(4)`
– `mds-time-capab-sync-rel-time(5)`

– `mds-time-capab-sync-hi-res-relative-time(6)`
– `mds-time-capab-bo-time(7),`
– `mds-time-state-abs-time-synced(8)`
– `mds-time-state-rel-time-synced(9)`
– `mds-time-state-hi-res-relative-time-synced(10)`
– `mds-time-mgr-set-time(11)`
– `mds-time-capab-sync-bo-time(12)`
– `mds-time-state-bo-time-synced(13)`
– `mds-time-state-bo-time-UTC-aligned(14)`
– `mds-time-dst-rules-enabled(15)`

One can then determine that the value 0100000100010010 indicates that the sensor's clock can be set, it is using base offset time, the PHG is to set its time, and the base offset's time base is UTC. The CWE encoded entry would then be

```
1^mds-time-capab-set-clock(1)~1^mds-time-capab-bo-time(7)~1^mds-time-mgr-set-time(11)~1^mds-time-state-bo-time-UTC-aligned(14)
```

or

```
1^(1)~1^(11)~1^(7)~1^(14)
```

It is also okay to have

```
1^(1)~1^mds-time-capab-bo-time(7)~1^(11)~1^(14)
```

or

```
1^(1)~0^(2)~1^(11)~1^(7)~1^(14)
```

Note that no order is required in the sequence of set bits though ordering is recommended.

### D.0.4.3 FLOAT and SFLOAT mapping

[ISO/IEEE 11073-20601] encodes many of its attribute values as 32-bit FLOAT or 16-bit SFLOATs. The decoding is straightforward. The 32-bit float contains an 8-bit exponent and a 24-bit mantissa which can be independently treated as signed integers for their respective bitness. Thus an 8-bit exponent with value 0x02 is the integer 2 while 0xFE is −2. However, what is often missed in the translation is the additional semantic meaning of the exponent; it defines not only the value but also the *precision*. Whenever the exponent is positive, the reported value is an integer; it has no fractional component. Thus, if the mantissa is 2 and the exponent 3, the value reported is 2000 ($2 \times 10^3$). On the other hand, if the exponent is negative, it indicates the number being reported has two factional decimal places of precision. Thus if the mantissa is 2 and the exponent −3, the value reported is 0.002 ($2 \times 10^{-3}$). If the mantissa is 2000 and the exponent −3, the value reported is 2.000 and not 2 or 2.0 or 2.00. The '−3' indicates three decimal places of fractional precision.

– Services observation uploaders **shall** encode FLOAT and SFLOATs according to the indicated precision.

### D.0.4.4 Sequence number and containment:

The generic rules for the sequence numbers and containment values of OBX segments in an OBR are as follows:

– OBX-1 **shall** start at one for the first OBX segment in an OBR and increase by one for every additional entry.
– The n-tuple in OBX-4 **shall** be unique within a given OBR.
  - o Remark 1: There is no relationship between the sequence number of the OBR segment and the MDS-tuple value in OBX-4
  - o Remark 2: There is no relationship between the hierarchies in OBR segment N with those in OBR segment M.

- o Remark 3: There is no relationship between the metric n-tuple value and the handle value of an ISO/IEEE 11073-20601 object.
- o Remark 4: There is no semantic meaning to the absolute numerical values of the n-tuple in the hierarchy in the sense of order or time; their sole purpose is to establish the scoping (containment) of the segments

In the following clause a normative reference to a single OBX segment is frequently made since certain fields have fixed values. However, in a PCD-01 document the segment will generally appear somewhere in a sequence of OBX segments, thus it is not possible to know ahead of time what the sequence number and value of the MDS-tuple, channel-tuple and metric-tuple are. These values depend upon the other segments already present in the document. To indicate this situation, when an OBX segment is shown with OBX-1 = *n*, the sequence number '*n*' indicates one after the sequence number of the OBX segment prior to it. When an OBX segment is shown with an OBX-4 hierarchy *m*.0.*c*. *x*, the '*m*' indicates the MDS instance the segment is a member of, '*c*' indicates the channel instance, and '*x*' indicates the metric instance. If the hierarchy is shown as *m*.0.0.*x*.*y*, the '*y*' indicates a facet to the OBX segment with MDS instance *m* and metric instance *x* (currently there is no situation where a channel instance will have a facet so the case *m*.0.*c*.*x*.*y* does not occur). When discussing multiple facets of a single OBX metric instance, different variables are used for the facet-tuple as the order of the facet segments and the numbering of the facet tuple scoped by a given metric instance is up to the implementer. Dictionary (numeric) ordering is preferred to the extent possible.

## D.1 OBX encoding guidelines

### D.1.1 Guidelines for encoding the PHG-OBX segments

There are properties that a PHG possesses that are sent in a special set of 'MDS-value-0' OBX segments. For service (agent) components, the values placed in the OBX entries are based upon attributes. However, attributes are not defined on a PHG. For convenience and consistency with the encoding of the OBX entries of the MDS for service components, the PHG will be treated as if it could contain four hypothetical 'PHG' attributes in a hypothetical MDS object:

- a PHG-RegCertDataList attribute which is mandatory;
- a PHG-MdsTimeInfo attribute which is mandatory;
- a PHG-RelativeTime attribute which is mandatory if the PHG has a relative time clock that is used in synchronization with relative timestamps on sensor devices;
- a PHG-HiResRelativeTime attribute which is mandatory if the PHG has a high resolution relative time clock that is used in synchronization with relative timestamps on sensor devices.

The properties of the PHG are populated into these hypothetical attributes as they would be if the PHG were an ISO/IEEE 11073-20601 service component (agent). These hypothetical attributes are only for the convenience of describing the encoding of the PHG OBX segments, and have no meaning outside of that purpose. There is no requirement that these attributes or MDS object exist on the PHG.

PHG-OBX segments describe the properties and features of the PHG.

- Every Continua PCD-01 document **shall** contain one set of PHG-OBX segments.
- The PHG-OBX segments **shall** be the first OBX segments in the document.
- The PHG-OBX segments **shall** only be in the first OBR.
- The PHG-OBX segments **shall** be encoded as dictated in this clause.
- The MDS-n-tuple in the OBX-4 hierarchy for all PHG-OBX segments **shall** be 0.

– For all PHG-OBX segments, OBX-11 **shall** be 'R' except for the top-level OBX which **shall** be X.

### D.1.1.1 Top-Level PHG-OBX

There **shall** be a top-level PHG-OBX.

The top level PHG-OBX **shall** be the first OBX segment in the document.

The top level PHG-OBX **shall** be:

```
OBX|1||531981^MDC_MOC_VMS_MDS_PHG^MDC|0||||||X|||||||obx-18
```

where *obx-18* **shall** be the PHG's system id encoded as an EI data type where

– EI-1 is some unique identifier. A repeat of EI-3 may be used here.

– EI-3 is the PHG system id as a 16-digit HEX string (without a 0x prefix).

– EI-4 is EUI-64.

Example:

```
OBX|1||531981^MDC_MOC_VMS_MDS_PHG^MDC|0||||||X|||||||0000ABEEDEADBEEF^^0000ABEEDEADBEEF^EUI-
64
```

### D.1.1.2 Regulation and certification OBX segments

The PHG **shall** report the Continua version and sensor specializations it has been certified for in three OBX segments as follows:

– The first OBX **shall** be the Continua auth body certification OBX segment:

```
OBX|n|CWE|68218^MDC_REG_CERT_DATA_AUTH_BODY^MDC|0.0.0.x|2^auth-body-
continua||||||R
```

– The Continua version the PHG has been certified for **shall** be encoded into a facet OBX segment as follows:

```
OBX|n|ST|532352^MDC_REG_CERT_DATA_CONTINUA_VERSION^MDC|0.0.0.x.y| obx-
5||||||R
```

where *obx-5* **shall** be the Continua version the PHG is certified for as 'major version'.'minor version'; for example '1.5'.

Example:

```
OBX|n|ST|532352^MDC_REG_CERT_DATA_CONTINUA_VERSION^MDC|0.0.0.x.y|1.5||||||R
```

– The sensor specializations the PHG has been certified for **shall** be encoded into a facet OBX segment as follows:

```
OBX|n|NM|532353^MDC_REG_CERT_DATA_CONTINUA_CERT_DEV_LIST^MDC|0.0.0.x.z|obx-
5||||||R
```

where *obx-5* **shall** be the list of 16-bit integers representing the Continua defined transport Tcode and sensor specialization code ([MDC_DEV_SPEC_PROFILE_*] − 4096 + Tcode * 8192) encoded as an NM data type separated by the repetition symbol '~'. The Tcode values are:

- 0 = Continua version 1 (pre-Tcode value)
- 1 = USB
- 2 = Bluetooth
- 3 = ZigBee
- 4 = Bluetooth Low Energy

Example for a blood pressure cuff (MDC_DEV_SPEC_PROFILE _BP =4103) supporting Bluetooth (Tcode = 2) and USB (Tcode = 1):

```
OBX|n|NM|532353^MDC_REG_CERT_DATA_CONTINUA_CERT_DEV_LIST^MDC|0.0.0.x.z|16391~8199|||||R
```

The entire set:

```
OBX|n|CWE|68218^MDC_REG_CERT_DATA_AUTH_BODY^MDC|0.0.0.x|2^auth-body-continua|||||R
OBX|n+1|ST|532352^MDC_REG_CERT_DATA_CONTINUA_VERSION^MDC|0.0.0.x.1|5.0|||||R
OBX|n+2|NM|532353^MDC_REG_CERT_DATA_CONTINUA_CERT_DEV_LIST^MDC|0.0.0.x.2|16391~8199|||||R
```

Note that the order of the two facet OBX segments in this group is up to the implementation.

The PHG **shall** report its regulation status in two OBX segments as follows:

– The first OBX **shall** be the Continua auth-body regulation OBX segment:

```
OBX|n|CWE|68218^MDC_REG_CERT_DATA_AUTH_BODY^MDC|0.0.0.x|2^auth-body-
continua|||||R
```

– The regulation status of the PHG **shall** be encoded into a facet OBX segment as follows:

```
OBX|n|CWE|532354^MDC_REG_CERT_DATA_CONTINUA_REG_STATUS^MDC|0.0.0.x.y|obx-
5||||||R
```

where *obx-5* **shall** be the regulation status BITS encoded as a CWE data type. CWE-1 is the bit setting and CWE-2 the ASN.1 name with the bit position in parentheses. At this time there is only one bit setting defined

o unregulated-device(0)

Example:

```
OBX|n|CWE|532354^MDC_REG_CERT_DATA_CONTINUA_REG_STATUS^MDC|0.0.0.x.y|1^unre
gulated-device(0)||||||R
```

The entire set

```
OBX|n|CWE|68218^MDC_REG_CERT_DATA_AUTH_BODY^MDC|0.0.0.x|2^auth-body-
continua|||||R
OBX|n+1|CWE|532354^MDC_REG_CERT_DATA_CONTINUA_REG_STATUS^MDC|0.0.0.x.1|1^un
regulated-device(0)||||||R
```

The PHG **shall** report the services Continua capability classes it is certified for in two OBX segments as follows:

– The first OBX **shall** be the Continua auth body services certification OBX segment.

```
OBX|n|CWE|68218^MDC_REG_CERT_DATA_AUTH_BODY^MDC|0.0.0.x|2^auth-body-
continua|||||R
```

– The health and fitness service classes that the PHG has been certified for **shall** be encoded into a facet OBX segment as follows:

```
OBX|n|CWE|532355^MDC_REG_CERT_DATA_CONTINUA_PHG_CERT_LIST^MDC|1.0.0.x.y|obx
-5||||||R
```

where *obx-5* **shall** be the list of services certified device class codes encoded as a CWE data type separated by the repetition character (~). Currently the following are defined:

o 0^observation-upload-soap

o 1^consent-enabled-soap

o 2^ capability-exchange

o 3^observation-upload-hdata

- o 4^consent-enabled-hdata
- o 5^questionnaire
- o 6^aps

Example:

```
OBX|n+1|CWE|532355^MDC_REG_CERT_DATA_CONTINUA_PHG_CERT_LIST^MDC|1.0.0.x.1|0^observation-
upload-soap~2^capability-exchange~6^aps||||||R
```

A final example of the entire set of PHG certification and regulation OBXes with the top-level OBX is shown below:

```
OBX|1||531981^MDC_MOC_VMS_MDS_PHG^MDC|0||||||X|||||||0000ABEEDEADBEEF^^0000ABEEDEADBEEF^EUI-
64
OBX|2|CWE|68218^MDC_REG_CERT_DATA_AUTH_BODY^MDC|0.0.0.1|2^auth-body-continua||||||R
OBX|3|ST|532352^MDC_REG_CERT_DATA_CONTINUA_VERSION^MDC|0.0.0.1.1|5.0||||||R
OBX|4|NM|532353^MDC_REG_CERT_DATA_CONTINUA_CERT_DEV_LIST^MDC|0.0.0.1.2|16391~8199||||||R
OBX|5|CWE|68218^MDC_REG_CERT_DATA_AUTH_BODY^MDC|0.0.0.2|2^auth-body-continua||||||R
OBX|6|CWE|532354^MDC_REG_CERT_DATA_CONTINUA_REG_STATUS^MDC|0.0.0.2.1|1^unregulated-
device(0)||||||R
OBX|7|CWE|68218^MDC_REG_CERT_DATA_AUTH_BODY^MDC|0.0.0.3|2^auth-body-continua||||||R
OBX|8|CWE|532355^MDC_REG_CERT_DATA_CONTINUA_PHG_CERT_LIST^MDC|0.0.0.3.1|0^observation-upload-
soap~2^capability-exchange~6^aps||||||R
```

### D.1.1.3 System model

The PHG may report information equivalent to that provided by the System-Model attribute. If the PHG reports this information, it shall be encoded as follows for each quantity that is to be specified:

The model number shall be encoded as

```
OBX|n|ST|531969^MDC_ID_MODEL_NUMBER^MDC|0.0.0.x|obx-5||||||R
```

where *obx-5* shall be the model-number as a 127-bit ASCII string.

The manufacturer shall be encoded as

```
OBX|n|ST|531970^MDC_ID_MODEL_MANUFACTURER^MDC|0.0.0.x|obx-5||||||R
```

where *obx-5* shall be the manufacturer name as a 127-bit ASCII string.

Example:

```
OBX|n|ST|531970^MDC_ID_MODEL_MANUFACTURER^MDC|0.0.0.x|ContinuaPHGs Inc||||||R
OBX|n+1|ST|531969^MDC_ID_MODEL_NUMBER^MDC|0.0.0.x+1|39597-PHG||||||R
```

### D.1.1.4 Production specification

The PHG **may** report equivalent information to that provided by the Production-Specification attribute. If the PHG reports this information, it **shall** be encoded as follows for each quantity that is to be specified:

```
OBX|n|ST|obx-3|0.0.0.x|obx-5||||||R
```

where

– *obx-3* is given by Table D.3.

**Table D.3 – Continua services PHG production specification nomenclature codes**

| Quantity to enter in obx-5 | *obx-3 field* |
|---|---|
| Serial number | 531972^MDC_ID_PROD_SPEC_SERIAL^MDC |
| Part number | 531973^MDC_ID_PROD_SPEC_PART^MDC |
| Hardware revision | 531974^MDC_ID_PROD_SPEC_HW^MDC |
| Software revision | 531975^MDC_ID_PROD_SPEC_SW^MDC |
| Firmware revision | 531976^MDC_ID_PROD_SPEC_FW^MDC |
| Protocol | 531977^MDC_ID_PROD_SPEC_PROTOCOL^MDC |
| Global medical device nomenclature (GMDN) | 531978^MDC_ID_PROD_SPEC_GMDN^MDC |

– *obx-5* shall be the appropriate 127-bit ASCII alpha-numeric string describing the quantity as specified in the OBX-3 field. Be sure to HL7-escape any separator characters in the string.

#### D.1.1.5 Time synchronization capabilities

The PHG **shall** report its time synchronization capability in an OBX segment encoded as follows:

```
OBX|n|CWE|68220^MDC_TIME_SYNC_PROTOCOL^MDC|0.0.0.x|obx-5||||||R
```

where obx-5 **shall** be one of the synchronization protocols given in Table D.19. If the PHG has lost synchronization to NTP (its accuracy is less than five minutes) the PHG shall report `532224^MDC_TIME_SYNC_NONE^MDC`.Note that the interpretation of the time sync protocol in PCD is different to its meaning in [ISO/IEEE 11073-20601]. In the latter, the time sync protocol reported by the sensor indicates only the *method* by which the sensor synchronizes. The time capabilities bits entry of the Mds-Time-Info attribute indicates whether or not the sensor is actually synchronized. In the PCD environment, the time sync protocol indicates both the method and that it is currently synchronized by that method.

In many of the popular operating systems on which PHGs are run it may not be possible to obtain the time synchronization state and thus accuracy since users are free to change these settings. In these situations it can be difficult to determine if synchronization has been lost. In the 'EBWW' (eyeball and wrist watch) case, a default accuracy is taken to be about two minutes.

Example:

```
OBX|n|CWE|68220^MDC_TIME_SYNC_PROTOCOL^MDC|0.0.0.x|532234^MDC_TIME_SYNC_
EBWW^MDC||||||R
```

#### D.1.1.6 TimeInfo information

The PHG may wish to report some of its time capabilities. It does not make any sense to report a time capabilities BITs field analogous to that provided by the MdsTimeInfo attribute on the sensor device since the synchronization state AND method are indicated by the time synchronization protocol OBX and PHGs are required to be at least UTC aware.

##### D.1.1.6.1 Time synchronization accuracy

The PHG **may** report its time synchronization accuracy if known. If reported the OBX segment **shall** be encoded as follows:

```
OBX|n|NM|8221^MDC_TIME_SYNC_ACCURRACY^MDC|0.0.0.x|obx-
5|264339^MDC_DIM_MICRO_SEC^MDC|||||R
```

where *obx-5* **shall** be the 32-bit integer value of the accuracy in microseconds

Example:

```
OBX|n|NM|8221^MDC_TIME_SYNC_ACCURRACY^MDC|m.0.0.x|120000000|264339^MDC_DIM_
MICRO_SEC^MDC|||||R
```

### D.1.1.6.2 Time resolution of absolute or UTC clock

The PHG **may** report the resolution its clock used in the exchange protocol with the sensor. If reported, the OBX segment **shall** be encoded as follows:

```
OBX|n|NM|68226^MDC_TIME_RES_BO^MDC|0.0.0.x|obx-
5|264339^MDC_DIM_MICRO_SEC^MDC|||||R
```

where *obx-5* **shall** be the resolution of the clock in microseconds.

### D.1.1.6.3 Relative time clocks

The PHG shall only report its relative time clock information in the case it is providing a time synchronization service for sensor devices.

### D.1.1.7 PHG provides time service

If the PHG provides a relative time service that sensor devices can and do synchronize to, the PHG is required to provide additional information regarding this service according to the TimeStamp and time synchronization clause. The existence and support of such a time service is out of scope with respect to these design guidelines.

### D.1.2 Guidelines for encoding the MDS-OBX segments

MDS-OBXes describe the properties and features of the sensor. A new [ISO/IEEE 11073-20601] association or the handling of a Date-Time-Adjustment attribute requires the encoding of a new set of MDS-OBX segments. The conditions for a new set of MDS-OBX segments are less clear for Bluetooth low energy sensors. In this specification the mapping to MDS OBXes is defined in terms of the sensor MDS object and its concomitant attributes. There is no requirement that this object or its attributes actually exist on the sensor device or PHG. Any sensor device whose data can be mapped to this object and its attributes by the PHG can be translated to compliant MDS-OBX segments.

– The MDS-OBX segments **shall** be encoded as dictated in this clause.

– For all MDS-OBX segments, OBX-11 **shall** be 'R', *except* for the top-level OBX which **shall** be 'X'.

### D.1.2.1 Top-level MDS-OBX (System-Id, System-Type, System-Type-Spec-List Attributes)

Every new association or new OBR **shall** contain a top-level MDS-OBX encoded as follows:

```
OBX|n||obx-3|m||||||X|||||||obx-18
```

where

*obx-3* shall contain the sensor specialization encoded as a CWE data type.

– The sensor specialization **shall** come from either the System-Type attribute or the System-Type-Spec-List attribute. [ISO/IEEE 11073-20601] states that the sensor MDS object can have either the System-Type-Spec-List or System-Type attribute, but *not* both.

– If the System-Type-Spec-List attribute contains more than one entry

  o *obx-3* **shall** be set to 528384^MDC_DEV_SPEC_PROFILE_HYDRA^MDC indicating the sensor supports multiple specializations.

- An additional MDS-OBX **shall** be generated. See System-Type-Spec-List attribute encoding for details.

*obx-18* **shall** contain the sensor's system id encoded as an EI data type where.

– EI-1 is an entity identifier which may be the same as EI-3.

– EI-3 is the system id as a 16-digit HEX string (without a 0x prefix) taken from the system id of the System-Id attribute.

– EI-4 is EUI-64.

Example:

```
OBX|n||528388^MDC_DEV_SPEC_PROFILE_PULS_OXIM^MDC|m||||||X||||||
0022D6EE4AFBD410^^0022D6EE4AFBD410^EUI-64
```

The System-Type-Spec-List attribute **shall** only be encoded if it contains more than one entry.

If the System-Type-Spec-List attribute is to be encoded, it **shall** be encoded as follows:

```
OBX|n|CWE|68186^MDC_ATTR_SYS_TYPE_SPEC_LIST^MDC|m.0.0.x|obx-5||||||R
```

where

– *obx-5* **shall** contain the list of specialization and/or profile entries as encoded as CWE data types separated by the repetition symbol '~'.

Example where the System-Type-Spec-List follows the top-level MDS-OBX and contains the body composition and pulse oximeter specializations:

```
OBX|n||528384^MDC_DEV_SPEC_PROFILE_HYDRA^MDC|m||||||X||||||0022D6014AFBD4
18^^0022D6014AFBD418^EUI-64
OBX|n+1|CWE|68186^MDC_ATTR_SYS_TYPE_SPEC_LIST^MDC|m.0.0.1|528404^MDC_DEV_SP
EC_PROFILE_BCA^MDC~528388^MDC_DEV_SPEC_PROFILE_PULS_OXIM^MDC||||||R
```

#### D.1.2.2 System-Model attribute

The System-Model attribute **shall** be translated to the OBX segments as specified in this clause if present. It is required by [ISO/IEEE 11073-20601].

The System-Model attribute **shall** be represented by two OBX segments as follows:

– The ASN.1-model-number **shall** be encoded as

```
OBX|n|ST|531969^MDC_ID_MODEL_NUMBER^MDC|m.0.0.x|obx-5||||||R
```

where *obx-5* **shall** be the string obtained from the ASN.1-model-number value of the attribute.

– The ASN.1-manufacturer **shall** be encoded as

```
OBX|n|ST|531970^MDC_ID_MODEL_MANUFACTURER^MDC|m.0.0.x|obx-5||||||R
```

where *obx-5* **shall** be the string obtained from the ASN.1-manufacturer value. Be sure to HL7-escape any separator characters in the string.

Examples:

```
OBX|n|ST|531970^MDC_ID_MODEL_MANUFACTURER^MDC|m.0.0.x|ContinuaSensors Inc||||||R
OBX|n+1|ST|531969^MDC_ID_MODEL_NUMBER^MDC|m.0.0.x+1|39596-AAA||||||R
```

#### D.1.2.3 Production-Specification attribute

The Production-Specification attribute **shall** be translated to the OBX segments as specified in this clause if present; Continua requires this attribute and that it has at least the Firmware and Serial

ASN.1-spec-type entries; in [ISO/IEEE 11073-20601] this attribute is optional. The attribute contains a sequence of ASN.1-ProdSpecEntry structs.

The Production-Specification attribute **shall** be encoded into one OBX for each ASN.1-ProdSpecEntry struct present in the attribute as follows:

```
OBX|n|ST|obx-3|m.0.0.x|obx-5|||||R||||||obx-18
```

where for each ASN.1-ProdSpecEntry:

– *obx-3* is given by Table D.4.

**Table D.4 – Continua services sensor production specification nomenclature codes**

| ASN.1 spec-type value | ***obx-3 field*** |
|---|---|
| unspecified(0) | 531971^MDC_ID_PROD_SPEC_UNSPECIFIED^MDC |
| serial(1) | 531972^MDC_ID_PROD_SPEC_SERIAL^MDC |
| part(2) | 531973^MDC_ID_PROD_SPEC_PART^MDC |
| hardware(3) | 531974^MDC_ID_PROD_SPEC_HW^MDC |
| software(4) | 531975^MDC_ID_PROD_SPEC_SW^MDC |
| firmware(5) | 531976^MDC_ID_PROD_SPEC_FW^MDC |
| protocol(6) | 531977^MDC_ID_PROD_SPEC_PROTOCOL^MDC |
| GMDN(7) | 531978^MDC_ID_PROD_SPEC_GMDN^MDC |

– *obx-5* **shall** be the string obtained from the ASN.1-product-spec for that ASN.1-ProdSpecEntry. Be sure to HL7-escape any separator characters in the string.

– *obx-18* **may** be used to encode the ASN.1-component-id value of the ASN.1 ProdSpecEntry as follows:

  o The ASN.1-component-id is a 16-bit integer interpreted as a private OID. The Production-Specification attribute contains no additional information with respect to this value. If the value is encoded into *obx-18* it shall be encoded as an EI data type as follows:

    ▪ EI-1 the PrivateOID as digits

    ▪ EI-2 the name 'PrivateOID'

    ▪ EI-3 the system id obtained from the System-Id attribute

    ▪ EI-4 the name 'EUI-64'

Example for a production-specification attribute with three ASN.1- ProdSpecEntry structs where one entry 'BCA&Weight-444.4' needs to be escaped:

```
OBX|n|ST|531976^MDC_ID_PROD_SPEC_FW^MDC|m.0.0.x|Revision_14.5|||||R||||||
64777^PrivateOID^0022D6014AFBD418^EUI-64
OBX|n+1|ST|531972^MDC_ID_PROD_SPEC_SERIAL^MDC|m.0.0.x+1|1203ARF33342|||||R
OBX|n+2|ST|531975^MDC_ID_PROD_SPEC_SW^MDC|m.0.0.x+2|BCASensor3.3|||||R
OBX|n+3|ST|531974^MDC_ID_PROD_SPEC_HW^MDC|m.0.0.x+3|BCA\T\Weight-
444.4|||||R
```

### D.1.2.4 Date-and-Time attribute

The Date-and-Time attribute **shall** be translated to an OBX segment *if* present *and* the PHG determines that it is better synchronized than the sensor. See clause D.1.3.1.5 for details on how the PHG uses the sensor's Mds-Time-Info attribute to determine who has superior synchronization. Sensors that do not use an absolute timestamp in any measurements need not support this attribute.

If the sensor reports this attribute but does not use it in any observation being scoped by this MDS n-tuple, this OBX shall not be reported. This attribute is the sensor's sense of current time in the current time zone of the PHG.

The date-and-time attribute **shall** be encoded as follows:

```
OBX|n|DTM|67975^MDC_ATTR_TIME_ABS^MDC|m.0.0.x|obx-5||||||R|||obx-14
```

where:

– *obx-5* **shall** be the time reported in the attribute formatted as a DTM data type.

– *obx-14* **shall** be the PHG's current time formatted as a DTM data type.

In a test situation, the PHG:

– **shall** be able to be synchronized to NTP time

– the DTM data type in OBX-14 **shall** have the offset added to UTC time to get local time or −0000 if UTC only.

In an operational situation, the PHG:

– **may** report its current time as a local time if synchronization to NTP time is lost or becomes unavailable.

Example where the association occurred in the eastern time zone of the US during daylight savings time on 30 May at 12:23:16.258, where the sensor is 10 seconds slow:

```
OBX|n|DTM|67975^MDC_ATTR_TIME_ABS^MDC|m.0.0.x|20130530122306.00||||||R|||20
130530122316.258-0400
```

Note that this OBX is a coincident timestamp pair. The Date-and-Time attribute represents the current time in absolute time format. When the PHG obtains the value of this attribute it is assumed that it is the current time in the time zone of the PHG. Errors by the device user (for example forgetting to change times as the device is taken across time zones) are not and cannot be taken into account.

### D.1.2.5 Base-Offset-Time

The Base-Offset-Time attribute **shall** be translated to an OBX segment *if* present *and* the PHG determines that it is better synchronized than the sensor. See clause D.1.3.1.5 for details on how the PHG uses the sensor's Mds-Time-Info attribute to determine who has superior synchronization. Sensors that do not use a base offset timestamp in any measurements need not support this attribute. If the sensor reports this attribute but does not use it in any observation being scoped by this MDS n-tuple, this OBX shall not be reported. The Base-Offset-Time attribute contains a base time plus the offset in minutes to the local time. Note that the definition of the offset is opposite that of the offset in a DTM data type. In base-offset time, one adds the offset to the base time to get local time. In a DTM timestamp, one adds the offset to UTC to get the local time. But what is displayed in a DTM timestamp is the local time and not UTC. This attribute is the sensor's sense of current time in the current time zone of the PHG.

The Base-Offset-Time attribute shall be encoded as follows:

```
OBX|n|DTM|68225^MDC_ATTR_TIME_BO^MDC|m.0.0.x|obx-5||||||R|||obx-14
```

where

– *obx-5* shall be the time reported in the attribute formatted as a DTM data type.

– *obx-14* shall be the PHG's current time formatted as a DTM data type.

In a test situation the PHG:

– shall be able to be synchronized to NTP time

– the DTM data type in OBX-14 shall have the offset to UTC time or -0000 if UTC only

In an operational situation the PHG:

– may report its current time as a local time if synchronization to NTP time is lost or becomes unavailable.

Example where the association occurred in the eastern time zone of the US during daylight savings time on 30 May at 16:23:16.258:

```
OBX|n|DTM|68225^MDC_ATTR_TIME_BO^MDC|m.0.0.x|20130530122316.455-
0400||||||R|||20130530122316.258-0400
```

Note that this OBX is a coincident timestamp pair. The Base-Offset-Time attribute represents the current time in Base offset time format. When the PHG obtains the value of this attribute it is assumed that it is the current time in the time zone of the PHG; in other words the base time plus offset gives the local current time in the time zone of the PHG. Errors by the device user (for example forgetting to change the offset as the device is taken across time zones) are not and cannot be taken into account.

### D.1.2.6 Relative-Time attribute

The Relative-Time attribute **shall** be translated to an OBX segment if present. Sensors that do not use a relative timestamp in any measurements need not support this attribute.

The Relative-Time attribute **shall** be encoded as follows:

```
OBX|n|NM|67983^MDC_ATTR_TIME_REL^MDC|m.0.0.x|obx-
5|264339^MDC_DIM_MICRO_SEC^MDC|||||R|||obx-14||||obx-18
```

where:

– *obx-5* shall be the 32-bit integer value of the time reported in the attribute converted from its units of 1/8 milliseconds to microseconds. The sent value is multiplied by 1000 and divided by 8.

– *obx-14* shall be the PHG's current time formatted as a DTM data type.

In a test situation the PHG:

– shall be able to be synchronized to NTP time

– the DTM data type in OBX-14 shall have the offset to UTC time or -0000 if UTC-only.

In an operational situation the PHG:

– may report only its current time as a local time if synchronization to NTP time is lost or becomes unavailable.

– *obx-18* may include an identifier for the timebase used by the sensor for the relative time clock as an EI data type*. Note that in this case only the first two components of the EI data type are used since the identifier (unlike a EUI-64) is not universal but 'local'.

NOTE * – Using the [ISO/IEEE 11073-20601] protocol the PHG cannot obtain the sensor's timebase information and the best the PHG can do is state that the timebase is the timebase of the sensor which would be indicated by EI-1 set to the ASN.1-system-id and EI-2 set to 'TIMEBASE_ID'. The entry provides no useful information.

The absence of an OBX-18 entry indicates that the PHG does not have any additional information over that which is implied.

The purpose of the OBX-18 entry is in the case where the PHG and sensor are implemented so that both are synchronized by the same relative time clock, for example a master Bluetooth clock. The scenario is likely in a hospital intensive care ward but unlikely in the home environment with Continua sensors. In addition the means to obtain that information is out of band with respect to any of the supported Continua interface protocols. If one has this situation, obx-18 should be appropriately valued.

Example with default timebase:

```
OBX|n|NM|67983^MDC_ATTR_TIME_REL^MDC|m.0.0.x|536870911875|264339^MDC_DIM_MI
CRO_SEC^MDC|||||R|||20130530122316.258-0400;
```

Example with out-of-band timebase information:

```
OBX|n|NM|67983^MDC_ATTR_TIME_REL^MDC|m.0.0.x|536870911875|264339^MDC_DIM_MI
CRO_SEC^MDC|||||R|||20130530122316.258-0400||||BT_ABCDEF123456^TIMEBASE_ID;
```

Note that this OBX is a coincident timestamp pair.

### D.1.2.7 HiRes-Relative-Time attribute

The HiRes-Relative-time attribute **shall** be translated to an OBX segment if present. Sensors that do not use a high resolution relative timestamp in any measurements need not support this attribute.

The HiRes-Relative-Time attribute **shall** be encoded as follows:

```
OBX|n|NM|68072^MDC_ATTR_TIME_REL_HI_RES^MDC|m.0.0.x|obx-
5|264339^MDC_DIM_MICRO_SEC^MDC|||||R|||obx-14||||obx-18
```

where:

– *obx-5* shall be the 64-bit integer value of the time reported in the attribute.

– *obx-14* shall be the PHG's current time formatted as a DTM data type.

In a test situation the PHG:

– shall be able to be synchronized to NTP time

– the DTM data type in OBX-14 shall have the offset to UTC time or -0000 if UTC-only.

In an operational situation the PHG:.

– may report only its current time as a local time if synchronization to NTP time is lost or becomes unavailable.

– *obx-18* may include an identifier for the timebase used by the sensor for the high resolution relative time clock as an EI data type. (See clause D.1.2.6 for clarification of this entry). Note that in this case only the first two components of the EI data type are used since the identifier, unlike the identification type EUI-64, is not universal but 'local'.

Example with default timebase:

```
OBX|n|NM|67983^MDC_ATTR_TIME_REL^MDC|m.0.0.x|1250000|264339^MDC_DIM_MICRO_S
EC^MDC|||||R|||20130530122316.258-0400;
```

Example with out-of-band timebase information:

```
OBX|n|NM|68072^MDC_ATTR_TIME_REL_HI_RES^MDC|m.0.0.x|1250000|264339^MDC_DIM_
MICRO_SEC^MDC|||||R|||20130530122316.258-
0400||||BT_ABCDEF123456^TIMEBASE_ID;
```

Note that this OBX is a coincident timestamp pair.

### D.1.2.8 Mds-Time-Info attribute

The Mds-Time-Info attribute **shall** be translated into OBX segments as specified in this clause if present; sensors that do not support any type of real time clock do not need to support this attribute. The Mds-Time-Info attribute is translated into up to six OBX segments.

The information reported in this attribute is used by the PHG to determine who has superior synchronization. See clause D.1.3.1.5 for details.

#### D.1.2.8.1 ASN.1-mds-time-cap-state

The ASN.1-mds-time-cap-state **shall** be encoded as follows:

```
OBX|n|CWE|68219^MDC_TIME_CAP_STATE^MDC|m.0.0.x|obx-5||||||R
```

where *obx-5* **shall** encode the ASN.1-mds-time-cap-state value as an ASN.1 BITs field as follows:

– each set bit is represented as a CWE data type with the bit setting CWE-1 and the string name followed by the bit position in parentheses in CWE-2

– set bits **shall** be included in the list

– cleared bits **may** be included in the list

– each CWE entry **shall** be separated by the repetition symbol '~'

– the possible entries **shall** be one or more of (from [ISO/IEEE 11073-20601])

```
o    <0 or 1>^mds-time-capab-real-time-clock(0)
o    <0 or 1>^mds-time-capab-set-clock(1)
o    <0 or 1>^mds-time-capab-relative-time(2)
o    <0 or 1>^mds-time-capab-high-res-relative-time(3)
o    <0 or 1>^mds-time-capab-sync-abs-time(4)
o    <0 or 1>^mds-time-capab-sync-rel-time(5)
o    <0 or 1>^mds-time-capab-sync-hi-res-relative-time(6)
o    <0 or 1>^mds-time-capab-bo-time(7)
o    <0 or 1>^mds-time-state-abs-time-synced(8)
o    <0 or 1>^mds-time-state-rel-time-synced(9)
o    <0 or 1>^mds-time-state-hi-res-relative-time-synced(10)
o    <0 or 1>^mds-time-mgr-set-time(11)
o    <0 or 1>^mds-time-capab-sync-bo-time(12)
o    <0 or 1>^mds-time-state-bo-time-synced(13)
o    <0 or 1>^mds-time-state-bo-time-UTC-aligned(14)
o    <0 or 1>^mds-time-dst-rules-enabled(15)
```

where the name `mds-time-*` is optional.

Note that settings referring to both Base-Offset time and Absolute-Time are not allowed.

Example (the first is preferred)

```
OBX|n|CWE|68219^MDC_TIME_CAP_STATE^MDC|m.0.0.x|1^mds-time-capab-real-time-clock(0)~1^mds-
time-capab-set-clock(1)~1^mds-time-capab-relative-time(2)~1^mds-time-mgr-set-time(11)||||||R
```

or

```
OBX|n|CWE|68219^MDC_TIME_CAP_STATE^MDC|m.0.0.x|1^(0)~1^(1)~1^(2)~1^(11)||||||R
```

#### D.1.2.8.2 ASN.1-time-sync-protocol

The semantic meaning for this MDS-OBX entry is different in PCD than in [ISO/IEEE 11073-20601]. In PCD an entry here indicates that the sensor not only uses this method to synchronize, but that it *is* synchronized using this method. The ISO/IEEE 11073-20601 sensor only indicates the *method* it uses to synchronize in this structure, the ASN.1- mds-time-cap-state indicates whether or not it is synchronized.

Thus, if the ASN.1-time-sync-protocol is not MDC_TIME_SYNC_NONE, the PHG needs to check the ASN.1- mds-time-cap-state first to see if the sensor indicates that it is synchronized. If it is, then then the PHG **shall** report the value in the ASN.1-time-sync-protocol struct in this OBX. If the ASN.1- mds-time-cap-state indicates the device is not synchronized, the value `532224^MDC_TIME_SYNC_NONE^MDC` **shall** be reported in the OBX.

The ASN.1-time-sync-protocol MDS-OBX **shall** be encoded as follows:

```
OBX|n|CWE|68220^MDC_TIME_SYNC_PROTOCOL^MDC|m.0.0.x|obx-5||||||R
```

where

obx-5 **shall** be the reported nomenclature code as a CWE data type if the sensor is synchronized. The attribute reports only the nomenclature code, the partition is implied to be nom-part-infrastruct. The currently defined synchronization protocols as a CWE data type are given in Table D.19. If the sensor is not synchronized, the value `532224^MDC_TIME_SYNC_NONE^MDC` **shall** be reported.

Example if synchronized (the first is preferred):

```
OBX|n|CWE|68220^MDC_TIME_SYNC_PROTOCOL^MDC|m.0.0.x|532234^MDC_TIME_SYNC_EBWW^MDC||||||R
```

or

```
OBX|n|CWE|68220^MDC_TIME_SYNC_PROTOCOL^MDC|m.0.0.x|532234^^MDC||||||R
```

Example if not synchronized

```
OBX|n|CWE|68220^MDC_TIME_SYNC_PROTOCOL^MDC|m.0.0.x|532224^MDC_TIME_SYNC_NONE^MDC||||||R
```

#### D.1.2.8.3 ASN.1-time-sync-accuracy

The ASN.1-time-sync-accuracy **shall not** be encoded into an OBX segment if the sent value is 0xFFFFFFFF which indicates the accuracy is unknown.

Otherwise the ASN.1-time-sync-accuracy **shall** be encoded as follows:

```
OBX|n|NM|8221^MDC_TIME_SYNC_ACCURRACY^MDC|m.0.0.x|obx-
5|264339^MDC_DIM_MICRO_SEC^MDC|||||R
```

where *obx-5* **shall** be the 32-bit integer value of the accuracy reported in the ASN.1-time-sync-accuracy converted from its units of 1/8 milliseconds to microseconds; the sent value is multiplied by 1000 and divided by 8. Note that a sent value of zero indicates an accuracy better than 125 microseconds but it cannot be resolved.

Example:

```
OBX|n|NM|8221^MDC_TIME_SYNC_ACCURRACY^MDC|m.0.0.x|9000000|264339^MDC_DIM_MI
CRO_SEC^MDC|||||R
```

#### D.1.2.8.4 ASN.1-time-resolution-abs-time

The ASN.1-time-resolution-abs-time **shall not** be encoded into an OBX segment if the value is 0 which indicates the resolution is unknown. Note that this struct is used for *both* absolute time and base-offset time accuracy; which of the two applies depends upon the capabilities settings. A sensor cannot support both absolute time and base-offset time during an association.

Otherwise the ASN.1-time-resolution-abs-time **shall** be encoded as follows:

```
OBX|n|NM|obx-3|m.0.0.x|obx-5|264339^MDC_DIM_MICRO_SEC^MDC|||||R
```

– If the `mds-time-capab-real-time-clock(0)` bit is set then
    - o *obx-3* **shall** be 68222^MDC_TIME_RES_ABS^MDC

- *obx-5* **shall** be the 16-bit integer value of the resolution reported in the ASN.1-time-resolution-abs-time converted from its units of 1/100ths seconds to microseconds; the value is multiplied by 10,000.

– If the `mds-time-capab-bo-time(7)` bit is set then
  - *obx-3* **shall** be 68226^MDC_TIME_RES_BO^MDC
  - *obx-5* **shall** be the 16-bit integer value of the resolution reported in the ASN.1-time-resolution-abs-time converted from its units of 1/65536ths of a second to microseconds; the value is multiplied by 1,000,000/65,536.

Example when supporting absolute time with 1-second resolution:

```
OBX|n|NM|68222^MDC_TIME_RES_ABS^MDC|m.0.0.x|1000000|264339^MDC_DIM_MICRO_SE
C^MDC|||||R
```

or when supporting base-offset time with 1/65536-th second resolution:

```
OBX|n|NM|68226^MDC_TIME_RES_BO^MDC|m.0.0.x|15.26|264339^MDC_DIM_MICRO_SEC^M
DC|||||R
```

#### D.1.2.8.5 ASN.1-time-resolution-rel-time

The ASN.1-time-resolution-rel-time **shall not** be encoded into an OBX segment if the sent value is 0 which indicates the resolution is unknown.

Otherwise the ASN.1-time-resolution-rel-time **shall** be encoded as follows:

```
OBX|n|NM|68223^MDC_TIME_RES_REL^MDC|m.0.0.x|obx-
5|264339^MDC_DIM_MICRO_SEC^MDC|||||R
```

where *obx-5* **shall** be the 32-bit integer value of the resolution reported in the ASN.1-time-resolution-rel-time converted from its units of 1/8th milliseconds to microseconds.

Example 1 relative-time unit resolution:

```
OBX|n|NM|68223^MDC_TIME_RES_REL^MDC|m.0.0.x|125|264339^MDC_DIM_MICRO_SEC^MDC|||||R
```

#### D.1.2.8.6 ASN.1-time-resolution-high-res-time

The ASN.1-time-resolution-high-res-time **shall not** be encoded into an OBX segment if the sent value is 0 which indicates the resolution is unknown.

Otherwise the ASN.1-time-resolution-high-res-time **shall** be encoded as follows:

```
OBX|n|NM|68224^MDC_TIME_RES_REL_HI_RES^MDC|m.0.0.x|obx-
5|264339^MDC_DIM_MICRO_SEC^MDC|||||R
```

where *obx-5* **shall** be the 64-bit integer value of the resolution reported in the ASN.1-time-resolution-high-res-time whose units are microseconds.

Example: 1 μs resolution

```
OBX|n|NM|68224^MDC_TIME_RES_REL_HI_RES^MDC|m.0.0.x|1|264339^MDC_DIM_MICRO_SEC^MDC|||||R
```

Example of the entire package when supporting absolute, relative and hi-res times:

```
OBX|n|CWE|68219^MDC_TIME_CAP_STATE^MDC|m.0.0.x|1^mds-time-capab-real-time-clock(0)~1^mds-
time-capab-set-clock(1)~1^mds-time-capab-relative-time(2)~1^mds-time-capab-high-res-relative-
time(3)~1^mds-time-capab-sync-abs-time(4)||||||R
OBX|n+1|CWE| 68220^MDC_TIME_SYNC_PROTOCOL^MDC|m.0.0.x+1|532234^MDC_TIME_SYNC_EBWW^MDC||||||R
OBX|n+2|NM|8221^MDC_TIME_SYNC_ACCURRACY^MDC|m.0.0.x+2|9000000|264339^MDC_DIM_MICRO_SEC^MDC|||
||R
OBX|n+3|NM|68222^MDC_TIME_RES_ABS^MDC|m.0.0.x+3|1000000|264339^MDC_DIM_MICRO_SEC^MDC|||||R
OBX|n+4|NM|68223^MDC_TIME_RES_REL^MDC|m.0.0.x+4|125|264339^MDC_DIM_MICRO_SEC^MDC|||||R
```

```
OBX|n+5|NM|68224^MDC_TIME_RES_REL_HI_RES^MDC|m.0.0.x+5|1|264339^MDC_DIM_MICRO_SEC^MDC||||R
```

### D.1.2.9 Reg-Cert-Data-List attribute

The Reg-Cert-Data-List attribute **shall** be translated into OBX segments as specified in this clause if present**.** Continua require that sensors have this attribute and the Continua defined auth-body ASN.1 structures. The attribute is optional in [ISO/IEEE 11073-20601].

Each ASN.1-reg-cert entry in the Reg-Cert-Data-List attribute **shall** be encoded as follows:

– The ASN.1-auth-body **shall** be encoded as follows:

```
OBX|n|CWE|68218^MDC_ATTR_REG_CERT_DATA_AUTH_BODY^MDC|m.0.0.x|obx-5||||||R
```

where *obx-5* **shall** be the ASN.1-auth-body 8-bit integer encoded as a CWE data type where CWE-1 is the integer value and CWE-2 is the name of the value as defined by [ISO/IEEE 11073-20601]. Current defined values expressed as CWE data types are one of:

- o `0^auth-body-empty`
- o `1^auth-body-ieee-11073`
- o `2^auth-body-continua`
- o `254^auth-body-experiemental`
- o `255^auth-body-reserved`

Example:

```
OBX|n|CWE|68218^MDC_ATTR_REG_CERT_DATA_AUTH_BODY^MDC|m.0.0.x|2^auth-body-continua||||||R
```

– If the ASN.1-auth-body value is 2 (ASN.1-auth-body-continua) and the ASN.1-auth-body-struct-type is the ASN.1-continua-version-struct (1)

o The ASN.1-major-IG-version and ASN.1-minor-IG-version **shall** be encoded into an OBX as follows:

```
OBX|n|ST|532352^MDC_REG_CERT_DATA_CONTINUA_VERSION^MDC|m.0.0.x.y|obx-
5||||||R
```

where *obx-5* **shall** be a combination of the ASN.1-major-IG-version value and ASN.1-minor-IG-version value separated by a dot, e.g., '3.5'

Example for version 4.0:

```
OBX|n|ST|532352^MDC_REG_CERT_DATA_CONTINUA_VERSION^MDC|m.0.0.x.y|4.0||||||R
```

o The ASN.1-certified-devices component **shall** be encoded into an OBX as follows:

```
OBX|n|NM|532353^MDC_REG_CERT_DATA_CONTINUA_CERT_DEV_LIST^MDC|m.0.0.x.y
|obx-5||||||R
```

where *obx-5* **shall** be the list of 16-bit integers representing the Continua defined transport Tcode and sensor specialization code (MDC_DEV_*_SPEC_PROFILE_* − 4096 + Tcode * 8192) encoded as an NM data type separated by the repetition symbol '~'.

Example:

```
OBX|n|NM|532353^MDC_REG_CERT_DATA_CONTINUA_CERT_DEV_LIST^MDC|m.0.0.x.y|4~8196~16388~245
80~7~8199~16391~24583~8~8200~16392~24584~15~8207~16399~24591~72~8264~16456~24648||||||R
```

– If the ASN.1-auth-body value is 2 (ASN.1-auth-body-continua) and the ASN.1-auth-body-struct-type is the ASN.1-continua-reg-struct (2)

o The regulation-bit-field **shall** be encoded into an OBX as follows:

```
OBX|n|CWE|532354^MDC_REG_CERT_DATA_CONTINUA_REG_STATUS^MDC|m.0.0.x.y|o
bx-5||||||R
```

where *obx-5* **shall** be the ASN.1-regulation-bit-field BITS value encoded as a CWE data type CWE-1 is the bit setting and CWE-2 the name with the bit position in parentheses. At this time there is only one bit setting defined:

- `unregulated-device(0)`

Example for unregulated device:

```
OBX|n|CWE|532354^MDC_REG_CERT_DATA_CONTINUA_REG_STATUS^MDC|m.0.0.x.y|1^unregulated-
device(0)||||||R
```

Example for regulated device:

```
OBX|n|CWE|532354^MDC_REG_CERT_DATA_CONTINUA_REG_STATUS^MDC|m.0.0.x.y|||||||R
```

or:

```
OBX|n|CWE|532354^MDC_REG_CERT_DATA_CONTINUA_REG_STATUS^MDC|m.0.0.x.y|0^unregulated-
device(0)||||||R
```

– If the ASN.1-auth-body value is not ASN.1-auth-body-continua no further encoding of the ASN.1-reg-cert component into OBX segments is required. At this time no further ASN.1-reg-cert entry types have been defined. However, if the structures are known corresponding OBX segments **should** be encoded.

An example of the entire Continua Reg-Cert-Data-List attribute encoding is shown below (the example sensor is certified for several specializations and transports):

```
OBX|n|CWE|68218^MDC_ATTR_REG_CERT_DATA_AUTH_BODY^MDC|m.0.0.x|2^auth-body-
continua||||||R
OBX|n+1|ST|532352^MDC_REG_CERT_DATA_CONTINUA_VERSION^MDC|m.0.0.x.1|4.0|||||
|R
OBX|n+2|NM|532353^MDC_REG_CERT_DATA_CONTINUA_CERT_DEV_LIST^MDC|m.0.0.x.2|4~
8196~16388~24580~7~8199~16391~24583~8~8200~16392~24584~15~8207~16399~24591~
72~8264~16456~24648||||||R
OBX|n+3|CWE|68218^MDC_ATTR_REG_CERT_DATA_AUTH_BODY^MDC|m.0.0.x+1|2^auth-
body-continua||||||R
OBX|n+4|CWE|532354^MDC_REG_CERT_DATA_CONTINUA_REG_STATUS^MDC|m.0.0.x+1.1|1^
unregulated-device(0)||||||R
```

Note that a `MDC_ATTR_REG_CERT_DATA_AUTH_BODY` OBX occurs for each ASN.1-reg-cert entry, one of which is the parent of the Continua Version Struct and the other is the parent of the Continua Regulation Status Struct.

### D.1.2.10 Tick-Resolution attribute

This attribute shall be encoded into an OBX segment as specified in this clause if present as follows:

```
OBX|n|NM|68229^MDC_ATTR_TICK_RES^MDC|m.0.0.x|obx-
5|268992^MDC_DIM_TICK^MDC|||||R
```

where *obx-5* shall be the number of ticks per second.

Note that this attribute is currently only required in the MDS object of the ECG specialization when the RR-interval is reported.

Example of 1024 ticks per second:

```
OBX|n|NM|68229^MDC_TICK_RESOLUTION^MDC|m.0.0.x|1024|268992^MDC_DIM_TICK^MDC|||||R
```

### D.1.2.11 Power-Status attribute

The encoding of this attribute into OBX segments is optional. If encoded it shall be encoded as follows:

```
OBX|n|CWE|67925^MDC_ATTR_POWER_STAT^MDC|m.0.0.x|obx-5||||||R
```

where *obx-5* **shall** be the value of the attribute encoded as a CWE data type. The attribute value is an ASN.1-BITS16 value and is one or more of:

```
o    onMains(0)
o    onBattery(1)
o    chargingFull(8)
o    chargingTrickle(9)
o    chargingOff(10).
```

Example:

```
OBX|n|NM|67925^MDC_ATTR_POWER_STAT^MDC|m.0.0.x|1^onMains(0)~1^chargingTrickle(9)||||||R
```

### D.1.2.12 Battery-Level attribute

The encoding of this attribute into OBX segments is optional. If encoded it **shall** be encoded as follows:

```
OBX|n|NM|67996^MDC_ATTR_VAL_BATT_CHARGE^MDC|m.0.0.x|obx-
5|262688^MDC_DIM_PERCENT^MDC|||||R
```

where *obx-5* **shall** be the value of the attribute. Note values greater than 100 are undefined and **should not** be transmitted.

Example:

```
OBX|n|NM|67996^MDC_ATTR_VAL_BATT_CHARGE^MDC|m.0.0.x|94.3|262688^MDC_DIM_PERCENT^MDC|||||R
```

### D.1.2.13 Remaining-Battery-Time attribute

The encoding of this attribute into OBX segments is optional. It is an MDER FLOAT. If encoded it **shall** be encoded as follows:

```
OBX|n|NM|67976^MDC_ATTR_TIME_BATT_REMAIN^MDC|m.0.0.x|obx-5|obx-6|||||R
```

where

– *obx-5* **shall** be the value given by the ASN.1-value struct

– *obx-6* **shall** be the value of the ASN.1-unit struct encoded as a CWE data type. The ASN.1-unit value is a nomenclature code from the MDC_PART_DIM (4) partition and is one of MDC_DIM_MIN, MDC_DIM_HR, or MDC_DIM_DAY.

Example:

```
OBX|n|NM|67976^MDC_ATTR_TIME_BATT_REMAIN^MDC|m.0.0.x|7.22|264384^MDC_DIM_HR^MDC|||||R
```

### D.1.2.14 Set Time action

If the sensor requests that its time is to be set, [ISO/IEEE 11073-20601] requires that the PHG must comply. If the sensor responds with a rors (success), the PHG **shall** assume that the sensor times are now synchronized with its clock. If the PHG has already created a coincident timestamp pair OBX from a previous GET request response, a new coincident timestamp pair OBX **shall** be created where OBX-5 and OBX-14 are now based upon the time the PHG sent in the SetTime or SetBOTime action. No new GET request is required. Since the sensor and PHG are synchronized, the PHG need only translate the sensor timestamps in scan event reports to local time plus offset, no corrections for clock skews are necessary. The sensor may or may not send a date-time-adjustment due to the Set Time action.

If the sensor has already sent observations on the previous timeline, the set time action breaks the timeline and the event needs to be handled as if a date-time-adjustment were received. If the actual adjustment is small (less than some value) then a new OBR is not needed; only an update of the coincident timestamp pair OBX is needed (see clause D.1.4.1).

#### D.1.2.15 Real time MDS-OBX attributes

[ISO/IEEE 11073-20601] allows the sensor to event dynamic and observational MDS attributes in scan event reports, for example, to update the battery level.

– Updates of the Power-Status, Battery-Level and remaining Battery-Time attributes **may** be encoded into their respective OBX segments as defined above.

– If a current time attribute is sent it **shall not** be encoded into an OBX segment as it does not represent any change in the time line and their inclusion could cause confusion. A change in the time line is indicated by a Date-Time-Adjustment attribute.

### D.1.3 Guidelines for encoding the Metric-OBX segments

Metric-OBX segments are generated from observations. In [ISO/IEEE 11073-20601], all physiological observations are represented by one of three classes of metric objects and the set of attributes (shown in Table D.20, Table D.21, Table D.22 and Table D.23) that represent observations in those objects. In this specification the mapping to Metric OBXes is defined in terms of these metric objects and their concomitant attributes. *There is no requirement that these objects or attributes actually exist on the sensor device or PHG.* Any sensor device whose data can be mapped to these objects and attributes by the PHG can be translated to compliant Metric-OBX segments.

Unlike the MDS-OBXes where a single attribute can map to one or more OBX segments, several attributes in the metric object representing the observation map to a single OBX segment. For example, in the non-compound case, the TYPE, Metric-Id, Metric-Id-Partition, Unit-code, the chosen observational attribute and timestamp, Measurement-Status, Unit-LabelString, Label-String and Enum-Observed-Value-Partition attributes are used to populate fields of a single OBX segment. The remaining non-protocol-specific attributes form facet OBX segments.

Given the observation in terms of the 11073-20601 metric object the attributes will be either mapped to:

1. a single ISO/IEEE 11073-20601 METRIC-level OBX segment with zero or more facet OBX segments

2. a single 11073-10201 CHANNEL-level OBX segment with one or more METRIC-level OBX segments.

Case 2 occurs only when the metric object has one of the three possible compound numeric attributes.

The guidelines in this clause are independent of specialization and indicate how one takes a generic metric object representing an observation and converts it into one or more OBX segments. In all cases there will be one parent OBX and zero or more child OBXes. In the non-compound case the parent OBX is at the METRIC-level. In the compound case the parent OBX is at the channel level. As of the writing of these guidelines, there are no cases where a 'child' OBX will also have a child.

For Continua certified Bluetooth low energy devices, the Transcoding White Paper [Bluetooth PHDT] provides the mapping of the characteristic values to hypothetical

ISO/IEEE 11073-20601 metric objects and attributes. Thus the guidelines provided here can be applied to these sensors as well.

Annex E provides a set of tables containing detailed information for specific attributes for the currently defined specializations. The tables will save one from reverting to the specialization documents to find, for example, the possible status bit settings for the pulse oximeter specialization device status measurement, the possible Unit-Codes for the thermometer specialization temperature measurement, etc.

#### D.1.3.1 Case 1: Measurement contains no compound attribute

In case 1 a single OBX segment is often sufficient to represent the observation. This single OBX segment is referred to as the METRIC-level OBX segment in this clause in reference to the 11073-10201 METRIC-level.

The conversion of an observation to PCD-01 OBX segment(s) can be summarized as follows:

– OBX-1 indicates the next OBX segment as always.

– OBX-2 and OBX-5 are determined by one of the value-type observational attributes of the metric object; there can be one and only one of these attributes in a given observation. OBX-5 is the value and OBX-2 is the data type. The list of [ISO/IEEE 11073-20601] value-type observational attributes and their corresponding data types is shown in Table D.5 (compound attributes are also shown).

**Table D.5 – Primary observational metric attributes**

| OBX-2 | Observational attribute |
|---|---|
| NM | Basic-Nu-Observed-Value |
| NM | Simple-Nu-Observed-Value |
| NM | Nu-Observed-Value |
| NA | Simple-Sa-Observed-Value |
| CWE | Enum-Observed-Value-Simple-Bit-Str |
| CWE | Enum-Observed-Value-Basic-Bit-Str |
| ST | Enum-Observed-Value-Simple-Str |
| CWE or ST | Enum-Observed-Value |
| NM | Compound-Basic-Nu-Observed-Value |
| NM | Compound-Simple-Nu-Observed-Value |
| NM | Compound-Nu-Observed-Value |

– OBX-3 is determined by the TYPE, Metric-Id, Metric-Id-Partition and Label-String attributes.

– OBX-4 shall indicate a new metric n-tuple value; a new metric instance.

– OBX-6 is determined by the Unit-Code attribute and the Unit-LabelString attribute.

– OBX-8 and OBX-11 are determined by the presence or lack of a Measurement-Status attribute OR a special numeric value like NaN:

  o No Measurement-Status or special value, OBX-8 is empty and OBX-11 is R.

– OBX-14 is determined by one of the timestamp attributes and if there is no timestamp attribute OBX-14 is filled in with the PHG's time of reception of the observation.

– OBX-20 is obtained from the Supplemental-Types attribute if it has any entries with a partition value of MDC_PART_SITES; otherwise the entries in the Supplemental-Types attribute are placed in a facet OBX.

– All the remaining fields are empty.

– A facet OBX to the above OBX is generated by the presence of the Supplemental-Types, Source-Handle-Reference, Source-Handle-Reference-List, Relative-Time-Stamp, HiRes-Time-Stamp and Sample-Period attribute.

– For some specializations additional attributes are defined that are not defined in [ISO/IEEE 11073-20601]. These attributes are also handled as facet OBX segments. The pulse oximeter specialization has also added two Measurement-Status bit settings not defined in [ISO/IEEE 11073-20601]. When these bits are set, they are represented as a facet OBX.

– All other attributes in the Metric object (such as the Attribute Value Map) are not of interest to PCD-01 and are not translated.

When the observation contains no compound attribute, a new metric instance OBX segment that may or may not require facet segments **shall** be encoded as follows:

```
OBX|n|obx-2|obx-3|m.0.0.x|obx-5|obx-6||obx-8|||obx-11|||obx-14||||||obx-20
```

where *obx-2, obx-3, obx-5, obx-6, obx-8, obx-11, obx-14,*and *obx-20* are encoded as specified in the following subclauses.

### D.1.3.1.1 obx-3

OBX-3 is always a CWE-encoded MDC code. The TYPE, Metric-Id, Metric-Id-Partition and Label-String Attributes are used to determine the value entered in the OBX-3 field. One or more of these attributes define what the observation *is*.

– If the Metric-Id attribute is not present,

  o OBX-3 **shall** be the TYPE attribute value, which contains both the nomenclature and partition code, encoded as a CWE data type. The TYPE attribute is required by [ISO/IEEE 11073-20601] and is always present.

  Example:

```
OBX|n|NM|150456^MDC_PULS_OXIM_SAT_O2^MDC|m.0.0.x|99|262688^MDC_DIM_PERCENT^MDC|||||R|||2009071
5070707-0500
```

– If the Metric-Id attribute is present

  o The Metric-Id value **shall** be encoded into a CWE data type using the Metric-Id-Partition attribute value for the partition if present or the partition value of the TYPE attribute value if the Metric-Id-Partition attribute is absent.

  o OBX-3 **shall** either be the Metric-Id value encoded as a CWE data type using the proper partition *or*

  o OBX-3 **shall** be the TYPE attribute value encoded as a CWE data type and

  o a facet OBX segment to the METRIC-level OBX segment **shall** be created as follows:

```
OBX|n|CWE|67883^MDC_ATTR_ID_PHYSIO^MDC|m.0.0.x.y|obx-5||||||obx-11
```

  NOTE – The reason for placing the Metric-Id value into a facet OBX segment is that the original version of the cardiovascular specialization [IEEE 11073-10441] used the Metric-Id to supplement the TYPE attribute and not as a replacement for the TYPE attribute. For example, the Metric-Id would specify 'Average or maximum' but one would not know the average or maximum of what without the TYPE attribute value. Sensors were implemented using this standard and are operational in the field. Thus by placing the Metric-Id attribute value into a facet OBX segment and maintaining the TYPE attribute value in the METRIC-level OBX segment, the full context of the observation can be read. This shortcoming has been fixed in the new version of the cardiovascular standard.

where

- *obx-5* **shall** be the Metric-Id value encoded as a CWE data type using the proper partition in the computation.
- *obx-11* **shall** have the same value as the parent OBX-11.

Examples:

Old version of cardiovascular fitness:

Speed Object TYPE value MDC_HF_SPEED partition MDC_PART_HF,

Metric-Id value indicates maximum value MDC_HF_MAX (same partition as TYPE).

Metric-Id replaces TYPE:

```
OBX|n|NM|16779218^MDC_HF_MAX^MDC|m.0.0.x|504|268704^MDC_DIM_M_PER_MIN^MDC|||||R|||200907
15070707-0500
```

Metric-Id as facet of METRIC-level OBX containing TYPE:

```
OBX|n|NM|16777326^MDC_HF_SPEED^MDC|m.0.0.x|404|268704^MDC_DIM_M_PER_MIN^MDC|||||R|||2009
0715070707-0500
OBX|n+1|CWE|67883^ MDC_ATTR_ID_PHYSIO^MDC|m.0.0.x.1|16779218^MDC_HF_MAX^MDC||||||R
```

– If the Label-String attribute is present its value **may** be appended to the alternate-text component (CWE-5) of the CWE data type in OBX-3 of the METRIC-level OBX segment. Be sure to HL7-escape any separator characters in the string.

Example:

```
OBX|n|NM|16779218^MDC_HF_MAX^MDC^^Runner's maximum speed during
workout|m.0.0.x|404|268704^MDC_DIM_M_PER_MIN^MDC|||||R|||20090715070707-0500
```

or

```
OBX|n|NM|16777326^MDC_HF_SPEED^MDC^^Runner's maximum speed during
workout|m.0.0.x|404|268704^MDC_DIM_M_PER_MIN^MDC|||||R|||20090715070707-0500
OBX|n+1|CWE|67883^ MDC_ATTR_ID_PHYSIO^MDC|m.0.0.x.1|16779218^MDC_HF_MAX^MDC||||||R
```

### D.1.3.1.2 obx-6

If present, the Unit-Code attribute value **shall** be encoded as a CWE data type in OBX-6 of the primary OBX segment. The partition code of MDC_PART_DIM (4) is assumed; the attribute value has only the nomenclature code.

Example:

```
OBX|n|NM|188736^MDC_MASS_BODY_ACTUAL^MDC|m.0.0.x|70.7|263875^MDC_DIM_KILO_G^MDC|||||R|||20120
628145624.000-0500
```

If present, the Unit-LabelString attribute value **may** be appended to the CWE data type in the Alternate-Text component which is of data type ST. Be sure to HL7-escape any separator characters in the string.

Example:

```
OBX|n|NM|152584^MDC_FLOW_AWAY_EXP_FORCED_PEAK^MDC|m.0.0.x|67.3|264992^MDC_DIM_L_PER_MIN^MDC^^B
reathing rate in liters per minute|||||R|||20090715070707+0800
```

### D.1.3.1.3 obx-2 and obx-5

The observational metric attributes define the OBX-2 and OBX-5 fields of the METRIC-level OBX segment.

#### D.1.3.1.3.1 Numeric observational attributes

If the observational attribute is a Basic-Nu-Observed-Value, Simple-Nu-Observed-Value, or Nu-Observed-Value

– OBX-2 **shall** be NM.

– If the value is a not a special value

  OBX-5 **shall** be the value of the attribute with precision as indicated by the exponent.

– If the value is a special value

  o OBX-5 **shall** be empty and OBX-8 and OBX-11 **shall** be encoded as in clause D.1.3.1.4.2 for handling the special values.

– If the observational attribute is a Nu-Observed-Val, which contains an ASN.1-state, ASN.1-unit-code and ASN.1-metric-id structure in addition to the value,

  o the Nu-Observed-Val attribute ASN.1 structs **shall** take precedence over the equivalent attributes (Metric-Id, Measurement-Status, Unit-Code) in the metric object.

    ▪ The ASN.1-metric-id value **shall** be handled as clause D.1.3.1.1.

    ▪ The ASN.1-state value **shall** be handled as in clause D.1.3.1.4.

    ▪ The ASN.1-unit-code value **shall** be handled as in clause D.1.3.1.2.

#### D.1.3.1.3.2 Enumeration observational attributes

There are four types of enumeration observational attributes.

##### D.1.3.1.3.2.1 Enum-Observed-Value-Simple/Basic-Bit-Str attributes

If the observational attribute is an Enum-Observed-Value-Simple-Bit-Str or Enum-Observed-Value-Basic-Bit-Str, ASN.1-BITS string encoding is used. All ASN.1 BITS16 and ASN.1 BITS32 are coded in this manner.

– OBX-2 **shall** be CWE.

– OBX-5 **shall** encode the ASN.1 BITS settings as a list of CWE data types where each entry is encoded as follows:

  o CWE-1 **shall** be the bit setting (1 or 0).

  o CWE-2 **shall** be the ASN.1 name if known concatenated by the bit position in parentheses. The bit position in parentheses **shall** be present whether or not the ASN.1 name is known.

  o CWE-3 is empty.

  o There **shall** be an entry for each bit that is set.

  o There **may** be an entry if the bit is cleared.

  o Each CWE entry **shall** be separated by the repetition symbol (~).

  Example:

  a) `1^device-battery-low(0)`
  b) `1^(0)`
  c) `1^device-battery-low(0)~1^sensor-read-interrupt(9)`
  d) `1^(0)~1^(9)`

  In cases a) and c) the name is known and in cases b) and c) it is not. Cases c) and d) represent more than one bit setting.

#### D.1.3.1.3.2.2 Enum-Observed-Value-Simple-OID attribute

If the observational attribute is an Enum-Observed-Value-Simple-OID, its value contains a 16-bit nomenclature code.

– OBX-2 **shall** be CWE.

– OBX-5 **shall** contain the nomenclature code into a CWE data type obtaining the partition as follows:

  - o If the Enum-Observed-Value-Partition attribute is present, the partition value from this attribute **shall** be used in the computation of the code in CWE-1.

  - o If the Enum-Observed-Value-Partition value is MDC_PART_SITES.

    - ▪ The encoded value **shall** be still be placed in OBX-5. In versions prior to this version of the guidelines it was placed in OBX-20.

  - o If the Enum-Observed-Value-Partition attribute is absent, the partition value from the TYPE attribute **shall** be used in the computation of the code in CWE-1.

#### D.1.3.1.3.2.3 Enum-Observed-Value-Simple-Str attribute

If the observational attribute is an Enum-Observed-Value-Simple-Str

– OBX-2 **shall** be ST.

– OBX-5 **shall** be the string of the Enum-Observed-Value-Simple-Str attribute value. Be sure to HL7-escape any separator characters in the string.

#### D.1.3.1.3.2.4 Enum-Observed-Value attribute

If the observational attribute is an Enum-Observed-Value the translation depends upon the type of data contained in the attribute. This attribute contains either an OID type, BITS-16 type, or String. Which of these types are in the attribute is determined by the ASN.1-value ASN.1 CHOICE entry. The CHOICE has one of the currently defined values of 1, 2 or 16.

– If the ASN.1-value CHOICE is 1 the value is an OID.

  - o OBX-2 **shall** be CWE.

  - o OBX-5 **shall** encode the nomenclature code from the ASN.1-value into a CWE data type.

    - ▪ If the Enum-Observed-Value-Partition attribute is present, the partition value from this attribute shall be used in the computation of the code in CWE-1.

    - ▪ If the Enum-Observed-Value-Partition value is MDC_PART_SITES.

      - • The encoded value **shall** be still be placed in OBX-5. In versions prior to this version of the guidelines it was placed in OBX-20.

    - ▪ If the Enum-Observed-Value-Partition attribute is absent, the partition value from the TYPE attribute **shall** be used in the computation of the code in CWE-1.

– If the ASN.1-value CHOICE is 2 the value is a string.

OBX-2 **shall** be ST.

OBX-5 **shall** be the string of the ASN.1-value value.

– If the ASN.1-value CHOICE is 16 the value is an ASN.1-BITS16.

  OBX-2 **shall** be CWE.

  OBX-5 **shall** encode the ASN.1 BITS settings in the ASN.1-value as a CWE data type as shown in the Enum-Observed-Value-*-Bit-Str attribute cases.

– The Enum-Observed-Value attribute ASN.1 structs **shall** take precedence over the equivalent attributes (Metric-Id and Measurement-Status) in the metric object.

  o The ASN.1-metric-id value **shall** be handled as clause D.1.3.1.1.

  o The ASN.1-state value **shall** be handled as in clause D.1.3.1.4.

#### D.1.3.1.3.3 Simple-Sa-Observed-Value attribute

If the observational attribute is a Simple-Sa-Observed-Value from the RTSA metric object.

– *obx-2* **shall** be NA.

– *obx-5* **shall** be the repeated sequence of entries in the Simple-Sa-Observed-Value attribute value scaled back to their original values separated by the component symbol (^) and not the repetition symbol (to be consistent with the current PCD representation of waveforms).

PDC is considering handling more complex notations, such as waveforms in multiple dimensions. In that case the time component of the RTSA may, in the future, be represented by the repetition symbol (~).

#### D.1.3.1.4 obx-8 and obx-11

Read clause D.1.3.1.7 for some background information.

If there is no Measurement-Status attribute or special value

– OBX-8 shall be empty.

– OBX-11 shall be R.

If there is a Measurement-Status attribute

– An entry from Table D.8 in clause D.1.3.1.7 which maps each bit setting in the Measurement-Status attribute to the appropriate HL7 AbnormalFlags string **shall** be added to OBX-8 using the repetition symbol (~) as needed.

– OBX-11 shall be encoded with the corresponding OBX-11 value as shown in Table D.8.

  o If there is more than one measurement status entry and the entries map to different OBX-11 values, 'X' **shall** take precedence over 'R' which **shall** take precedence over 'F'.

#### D.1.3.1.4.1 PulseOx and GCM Measurement-Status attribute bits 14 and 15 special case

If the Measurement-Status attribute has bits 14 or 15 set, these are special to the pulse oximeter and continuous glucose monitor specialization and these two settings are NOT reported in OBX-8 but are reported in a separate facet OBX segment as follows:

```
OBX|n|CWE|67911^MDC_ATTR_MSMT_STAT^MDC|m.0.0.x.y|obx-5||||||obx-11
```

where

– *obx-5* **shall** be the bit 14 and/or bit 15 entry encoded as a CWE type separated by the repetition symbol (~).

– *obx-11* **shall** be equal to OBX-11 of the parent.

#### D.1.3.1.4.2 Numeric special values NaN, +INF, -INF, NRes, Reserved

If there is a special value

– An entry from Table D.9 which maps the special value to the appropriate HL7 Abnormal Flags string **shall** be added to OBX-8 using the repetition symbol (~) if needed.

– OBX-11 shall be encoded with the corresponding OBX-11 value as shown in Table D.9

  o OBX-5 **shall** be set to empty.

    NOTE – OBX-5 needs to be set to empty as the [ISO/IEEE 11073-20601] SFLOAT and FLOAT encoded special values convert to valued numbers that will be misinterpreted.

#### D.1.3.1.5 obx-14: Timestamps

First a summary of PHG time requirements:

– The PHG **shall** be able to synchronize to UTC time and **should** be local time aware and **shall** generate qualified timestamps in MSH-7, OBR-7, OBR-8 and OBX-14.

  o If the PHG is not local time aware, it **shall** set the offset to -0000. The minus sign distinguishes it from a PHG that is local time aware but happens to be in a GMT time zone which, in that case, would use 0000 for the offset.

– If the PHG loses UTC time knowledge for some reason (no network connection and synchronization accuracy has decreased below some threshold), the PHG **may** fallback to using unqualified timestamps as indicated in clause D.1.5 should it be deemed necessary to still create a PCD-01 document. The fallback allows a PHG to generate a PCD-01 document that does not satisfy all the PCD timestamp requirements. The unqualified timestamp in MSH-7 indicates to the reader that the PHG has lost synchronization to UTC time. A PHG may still be able to report a qualified timestamp in OBR-7, OBR-8 and OBX-14 if the sensor happens to be synchronized to UTC and the PHG is aware of it.

– The PHG **shall** determine whether the sensor or the PHG is better synchronized to UTC.

  o It uses the sensor's Mds-Time-Info attribute to make this determination.

    ▪ The ASN.1-mds-time-caps-state indicates if the sensor is synchronized and to what.

    ▪ The ASN.1-time-sync-accuracy indicates the accuracy of the synchronization.

    ▪ The ASN.1-time-sync-protocol indicates the method the sensor uses to synchronize.

  o If the synchronization method, state of synchronization and synchronization accuracy indicate that the sensor is better synchronized to UTC than the PHG is, the PHG **shall** use the sensor's qualified timestamp without modification. This situation is case 2 in the timestamping and time synchronization clause D.1.5.

  o If the PHG determines that it has better synchronization it **shall** correct the sensor's timestamps. This situation is case 1 in the timestamping and time synchronization clause and it is what was done in all cases in versions prior to these design guidelines

– If the sensor provides no timestamp in the observation the PHG shall use the time of reception of the observation in OBX-14 regardless of whether case 1 or case 2 applies for time-stamped observations.

– The reader of the PCD-01 document determines the case from the existence or absence of the coincident timestamp pair MDS-OBX and Mds-Time-Caps MDS-OBX as indicated in Table D.6.

**Table D.6 – Timestamp cases**

| Time usage | Coincident timestamp pair OBX | Mds-Time-Caps OBX |
|---|---|---|
| PHG corrects sensor time | YES | YES |
| Sensor time used uncorrected | NO | YES |
| PHG uses time of reception | NO | NO |

OBX-14 guidelines:

– If the sensor provides no timestamp, case 3 of clause D.1.5 applies
  - o OBX-14 **shall** be the time the PHG received the observation as a DTM data type.

– If the sensor provides a timestamp and it is an absolute or base offset time, case 1 or 2 of clause D.1.5 applies.
  - o OBX-14 **shall** contain either the corrected Sensor timestamp (case 1) or uncorrected Sensor timestamp (case 2) as a DTM data type.

– If the sensor provides any type of relative timestamp,
  - o OBX-14 **shall** contain the PHG's conversion of this timestamp to a DTM timestamp using the coincident timestamp pair for the respective relative time (see clause 10.4).
  - o The relative time value itself **shall** be provided in its own facet OBX segment as indicated in clause D.1.3.1.6.

#### D.1.3.1.5.1 obx-20

This field is only encoded if there is a Supplemental-Types attribute and if any of the values in the attribute (which is a list of ASN.1 TYPE structs) have an MDC_PART_SITES partition. These entries with the MDC_PART_SITES partition value **shall** be encoded as a CWE data-type in OBX-20, separated by a repetition symbol (~) if needed. All other entries are encoded into a facet OBX segment as indicated in clause D.1.3.1.6.

#### D.1.3.1.6 Facet OBX segments

The remaining attributes in the Metric Object are all encoded as separate OBX segments which are facets of the METRIC-level OBX segment. If present, these attributes **shall** be handled as indicated in this clause.

#### D.1.3.1.6.1 Supplemental types

This attribute contains a list of partition:nomenclature values.

– If the partition is *not* MDC_PART_SITES the attribute shall be encoded as follows:

```
OBX|n|CWE|68193^MDC_ATTR_SUPPLEMENTAL_TYPES^MDC|m.0.0.x.y|obx-5||||||obx-11
```

where

  - o *obx-5* **shall** be the Supplemental-Types values whose partition is not MDC_PART_SITES as a CWE type separated by the repetition symbol (~).
  - o *obx-11* **shall** be equal to OBX-11 of the parent.

– If the partition is MDC_PART_SITES see clause D.1.3.1.5.1.

#### D.1.3.1.6.2 Source handle reference

This attribute contains an ISO/IEEE 11073-20601 handle pointing to another ISO/IEEE 11073-20601 metric object in the Sensor DIM. In PCD-01 handles are a meaningless concept. Thus the handle value is replaced with the OBX-4 value of the OBX METRIC-level segment that represents the observation being pointed to. Encoding this attribute is optional. If encoded, the attribute **shall** be encoded as follows:

```
OBX|n|ST|68167^MDC_ATTR_SOURCE_HANDLE_REF^MDC|m.0.0.x.y|obx-5||||||obx-11
```

where

– *obx-5* **shall** be the OBX-4 entry of the METRIC-level OBX segment this attribute value points to.

– *obx-11* **shall** be equal to OBX-11 of the parent.

Example: Source handle reference for body mass index in OBX|k+2| points to OBX|k| which contains the weight observation since OBX-5 of OBX|k+2| contains the OBX-4 value of OBX|k|:

– The PHG OBXes

```
OBX|n||528391^MDC_DEV_SPEC_PROFILE_SCALE^MDC|1|||||||X|||||||0123456789ABCD
EF^^0123456789ABCDEF^EUI-64
```

– More MDS OBXes

```
OBX|k|NM|188736^MDC_MASS_BODY_ACTUAL^MDC|1.0.0.x|80|263875^MDC_DIM_KILO_G^MDC|||||R
OBX|k+1|NM|188752^MDC_RATIO_MASS_BODY_LEN_SQ^MDC|1.0.0.x+1|24.7|264096^MDC_DIM_KG_PER_M_SQ^MDC
|||||R
OBX|k+2|ST|68167^MDC_ATTR_SOURCE_HANDLE_REF^MDC|1.0.0.x+1.1|1.0.0.x||||||R
```

### D.1.3.1.6.3 Source handle reference list

Same as Source-Handle-Reference except is contains a list of ISO/IEEE 11073-20601 handles. Encoding this attribute is optional. If encoded the attribute **shall** be encoded as follows:

```
OBX|n|ST|sssss^MDC_ATTR_SOURCE_HANDLE_REF_LIST^MDC|m.0.0.x.y|obx-
5||||||obx-11
```

where

– *obx-5* **shall** be the OBX-4 entries of the METRIC-level OBX segments this attribute value points to separated by the repetition symbol (~).

– *obx-11* **shall** be equal to OBX-11 of the parent.

### D.1.3.1.6.4 Measurement active period

This attribute contains the time over which the observation was taken in the units of seconds. If the value is valid, the attribute **shall** be encoded. If it is a special value, the attribute **should** be encoded. If the attribute is encoded it **shall** be encoded as follows:

```
OBX|n|NM|68185^MDC_ATTR_TIME_PD_MSMT_ACTIVE^MDC|m.0.0.x.y|obx-5|obx-
6|||||obx-11
```

where

– *obx-5* **shall** be the value of the attribute as seconds or scaled to microseconds.

– *obx-6* **shall** be 264320^MDC_DIM_SEC^MDC if OBX-5 is in seconds or 264339^MDC_DIM_MICRO_SEC^MDC if OBX-5 is scaled to microseconds. [ISO/IEEE 11073-20601] transmits this attribute in seconds.

– *obx-11* **shall** be equal to OBX-11 of the parent.

#### D.1.3.1.6.5 Accuracy

Attribute defines the maximum deviation of the actual observation from the sent observation. The deviation is in the units of the observation. The accuracy is an absolute value. The attribute **shall** be encoded as follows:

```
OBX|n|NM|67914^MDC_ATTR_NU_ACCUR_MSMT^MDC|m.0.0.x.y|obx-5|obx-6|||||obx-11
```

where

– *obx-5* **shal**l be the value of the attribute.

– *obx-6* **shall** be the value of the Unit-Code attribute as a CWE data type. It **shall** match OBX-6 of the parent OBX.

– *obx-11* **shall** be equal to OBX-11 of the parent.

#### D.1.3.1.6.6 Relative timestamp

This attribute gives the relative time in units of 1/8 ms. The attribute **shall** be encoded as follows:

```
OBX|n|NM|67985^MDC_ATTR_TIME_STAMP_REL^MDC|m.0.0.x.y|obx-
5|264339^MDC_DIM_MICRO_SEC^MDC|||||obx-11|||||||obx-18
```

where

– *obx-5* shall be the 32-bit integer value of the time reported in the attribute converted from its units of 1/8 milliseconds to microseconds.

– *obx-11* shall be equal to OBX-11 of the parent.

– *obx-18* may include an identifier for the timebase used by the sensor for the relative time clock as an EI data type if known (see Note in clause D.1.2.6).

#### D.1.3.1.6.7 Hi Res relative timestamp

This attribute gives the relative time in units of microseconds. The attribute **shall** be encoded as follows:

```
OBX|n|NM| 68073^MDC_ATTR_TIME_STAMP_REL_HI_RES^MDC|m.0.0.x.y|obx-
5|264339^MDC_DIM_MICRO_SEC^MDC|||||obx-11|||||||obx-18
```

where

– *obx-5* shall be the 64-bit integer value of the time reported in the attribute.

– *obx-11* shall be equal to OBX-11 of the parent.

– *obx-18* may include an identifier for the timebase used by the sensor for the relative time clock as an EI data type if known (see note in clause D.1.2.6).

#### D.1.3.1.6.8 Sample-Period

This attribute gives the time in 1/8 milliseconds between the samples in an RTSA observation. The attribute **shall** be encoded as follows:

```
OBX|n|NM|67981^MDC_ATTR_TIME_PD_SAMP^MDC|m.0.0.x.y|obx-
5|264339^MDC_DIM_MICRO_SEC^MDC|||||obx-11
```

where:

– *obx-5* shall be the 32-bit integer value of the time reported in the attribute scaled from 1/8 milliseconds to microseconds.

– *obx-11* **shall** be equal to OBX-11 of the parent.

#### D.1.3.1.6.9 SaFlags in Sa-Specification attribute

The ASN.1-flags struct of the Sa-Specification attribute contains information about the waveform which could be useful for displaying the waveform. This structure **may** be sent by applications. If sent, it **shall** be encoded as a facet OBX as follows:

```
OBX|n|CWE|531980^MDC_SA_SPECN_FLAGS^MDC OBX|m.0.0.x.y|obx-5||||||obx-11
```

where

– *obx-5* **shall** be encoded as an ASN.1-BITS field from one of the currently defined settings

```
o    smooth-curve(0)
o    delayed-curve(1)
o    static-scale(2)
o    sa-ext-val-range(3)
```

– *obx-11* **shall** be equal to OBX-11 of the parent.

#### D.1.3.1.6.10 Specialization specific metric attributes

The specialization-specific metric attributes are also encoded as facets.

#### D.1.3.1.6.10.1 Pulse Oximeter

– Alert-Op-State: Indicates whether the thresholds defined in the current limits are off. Note that a set bit means the alarm state is off. The segment **shall** be encoded as

```
OBX|n|CWE|67846^MDC_ATTR_AL_OP_STAT^MDC|m.0.0.x.y|obx-5||||||obx-11
```

where

o ***obx-5*** **shal**l be encoded as an Enum-Observed-Value-Basic-Bit-Str attribute value.

o ***obx-11*** **shall** be equal to OBX-11 of the parent.

Example:

```
OBX|n|CWE|67892^MDC_ATTR_AL_OP_STAT^MDC|m.0.0.x.y|0^limit-alert-off(0)~1^limit-low-off(1)||||||R
```

– Current-Limits: Has the lower followed by upper threshold limits for the said observation. The segment **shall** be encoded as

```
OBX|n|NM|67892^MDC_ATTR_LIMIT_CURR^MDC|m.0.0.x.y|obx-5|obx-6|||||obx-11
```

where

o ***obx-5*** **shal**l be the two values (lower limit then upper limit) of the attribute separated by the repetition symbol (~).

o ***obx-6*** **shall** be the Unit-Code attribute value.

o ***obx-11*** **shall** be equal to OBX-11 of the parent.

Example where thresholds are 30.3 beats per minute at the low end and 130.7 at the high end:

```
OBX|n|NM|67892^MDC_ATTR_LIMIT_CURR^MDC|m.0.0.x.y|30.3~130.7|264864^MDC_DIM_BEAT_PER_MIN^MDC|||||R
```

– Alert-Op-Text-String: Has strings representing the lower followed by upper threshold limits. The segment **shall** be encoded as

```
OBX|n|ST|68104^MDC_ATTR_AL_OP_TEXT_STRING^MDC|m.0.0.x.y|obx-5||||||obx-11
```

where

- o ***obx-5*** **shal**l be encoded as tuple of two strings (lower limit then upper limit) separated by the repetition symbol (~).
- o ***obx-11*** **shall** be equal to OBX-11 of the parent.

Example:

OBX|*n*|ST|68104^MDC_ATTR_AL_OP_TEXT_STRING^MDC|*m*.0.0.*x*.*y*|**lower pulse~upper pulse**||||||R

#### D.1.3.1.6.10.2 Adherence medication monitor (AMM)

Context-Key: EI data type giving an EUI-64 context identifier that by itself means nothing but it can be used to identify context for the given medication monitor, for example to determine what the medication actually is and what the feedback questions and answers actually are:

OBX|*n*|EI|68216^MDC_ATTR_CONTEXT_KEY^MDC|*m*.0.0.*x*.*y*|*obx-5*||||||R

where

– *obx-5* **shal**l be encoded as an EI data type where
  - o EI-1 is an entity identifier which may be the same as EI-3.
  - o EI-3 is the attribute value as a 16-digit HEX string (without the 0x prefix).
  - o EI-4 is EUI-64.

Example:

OBX|*n*|EI|68216^MDC_ATTR_CONTEXT_KEY^MDC|*m*.0.0.*x*.*y*|**AMM-Continua_5555^^00925555FD33AB10^EUI-64**||||||R

#### D.1.3.1.6.10.3 Continuous glucose monitor

– Threshold-Notification-Text-String: Has a string related to the current threshold notification. The segment **shall** be encoded as

OBX|*n*|ST|68104^MDC_THRES_NOTIF_TEXT_STRING^MDC|*m*.0.0.*x*.*y*|*obx-5*||||||*obx-11*

where

- o ***obx-5*** **shall** encoded as a string.Be sure HL7-escape any separator characters in the string.
- o ***obx-11*** **shall** be equal to OBX-11 of the parent.

Example:

OBX|*n*|ST|526984^MDC_ATTR_THRES_NOTIF_TEXT_STRING^MDC|*m*.0.0.*x*.*y*|**patient low threshold**||||||R

– Measurement-Confidence-95: Has the lower bound followed by upper bound within which the manufacture is 95% confident that the actual value for the said observation is within. The segment **shall** be encoded as

OBX|*n*|NM|526988^MDC_ATTR_MSMT_CONFIDENCE_95^MDC|*m*.0.0.*x*.*y*|*obx-5*|*obx-6*|||||*obx-11*

where

- o ***obx-5*** **shall** be the two values (lower boung then upper bound) of the attribute separated by the repetition symbol(~)

- ○ ***obx-6*** **shall** be the Unit-Code attribute value.
- ○ ***obx-11*** **shall** be equal to OBX-11 of the parent.

Example:

```
OBX|n|NM|526988^MDC_ATTR_MSMT_CONFIDENCE_95^MDC|m.0.0.x.y|6.5~7.8|266866^MDC_DIM_MILLI_MOLE_PE
R_L^MDC|||||R
```

#### D.1.3.1.7 Measurement status and special values (NaN, etc.)

[ISO/IEEE 11073-20601] can report the observation status in the Measurement-Status attribute as one or more of the following BITS values:

```
MeasurementStatus ::= BITS-16 {
     invalid(0),
     questionable(1),
     not-available(2),
     calibration-ongoing(3),
     test-data(4),
     demo-data(5),
     validated-data(8),      -- relevant, e.g., in an archive
     early-indication(9),    -- early estimate of value
     msmt-ongoing(10)   -- indicates a new observation is just being taken
(episodic)
}
```

The pulse oximeter and the continuous glucose monitor specializations define two additional bit settings:

– msmt-state-in-alarm(14) – indicates that the observation is outside threshold boundaries.

– msmt-state-al-inhibited(15) – indicates that the threshold indication is disabled.

The HL7 v2.6 OBX also contains the observation status concept, but allows only 1 value per OBX from the following set of possible values shown in Table D.7.

**Table D.7 – OBX-8 status values**

| Value | Description | Comment |
|---|---|---|
| O | Order received; specimen not yet received | |
| I | No results available; specimen received, procedure incomplete | |
| S | No results available; procedure scheduled, but not done | |
| A | Some, but not all, results available | |
| P | Preliminary: A verified early result is available, final results not yet obtained | |
| C | Correction to results | |
| R | Results stored; not yet verified | |
| F | Final results; results stored and verified. Can only be changed with a corrected result. | |
| X | No results available; order cancelled. | |

Table D.7 indicates that HL7 V2 does not have standard code values for expressing all the possible reasons a sensor can declare data as either 'invalid' or 'questionable', so there is a potential loss in semantic fidelity. However, HL7 v2.6 does provide an 'Abnormal Flags' field in OBX-8 that may be used to provide zero or more codes (of the IS data type) to augment the interpretation of the observation. For use on the Continua services interface, services Observation Upload devices use the 'Abnormal Flags' option whose values are shown in Table D.8 to report a standard Measurement Status value in OBX-8.

The OBX-8 settings also affect the OBX-11 'summary status' field as indicated in Table D.8. If more than one measurement status bit is set, the additional settings are included using the repetition symbol (~).

**Table D.8 – Measurement status values**

| MeasurementStatus ::= BITS-16 { ... } | OBX-8 | OBX-11 |
|---|---|---|
| No bits set ⇒ raw device observation; observation okay, has not been reviewed nor validated | | R |
| `invalid(0)` | INV | X |
| `questionable(1)` | QUES | R |
| `not-available(2)` | NAV | X |
| `calibration-ongoing(3)` | CAL | R |
| `test-data(4)` | TEST | R |
| `demo-data(5)` | DEMO | R |
| `validated-data(8)   -- relevant, e.g., in an archive` | | F |
| `early-indication(9) -- early estimate of value` | EARLY | R |
| `msmt-ongoing(10)    -- indicates that a new observation is just being taken (episodic)` | BUSY | X |
| `msmt-state-in-alarm(14) -- indicates that the metric has an active alarm condition` | ALACT | R |
| `msmt-state-al-inhibited(15)  -- metric supports alarming, and alarms are turned off (optional)` | ALINH | R |

Observations with a measurement status of validated-data **shall** use the final results code (F).

When the value of OBX-11 is set to 'X', as in the case of invalid, not-available or ongoing observations, it indicates that results **should not** be obtained from the observation. Non-device observations (e.g., physiological METRICS and FACETS) with an OBX-11 status code of 'X' **shall** set the value in OBX-5 to empty for NM data types. Previous versions of the standard stated that the value should be set to INV for all data types but that entry is not legal for the NM and NA data types and has caused problems in the field.

Also note that certain device specializations have extended this list of possible values. For these extended values, the Measurement-Status value **shall** be encoded in a FACET of the METRIC of question.

### D.1.3.1.8 Special values (NaN, etc.)

If a numeric value reports one of the [ISO/IEEE 11073-20601] special values (NaN, **NRes, +INFINITY, −INFINITY, or** Reserved) the case is also reported as an Abnormal Flags entry in OBX-8. This entry is appended to the Measurement-Status entries if present using the repetition symbol (~). [IHE-PCD-01] provides the codes based upon null flavors to handle invalid or missing data types. The values shown in Table D.9 are those appropriate for the special values.

**Table D.9 – Special data types**

| Missing, special or invalid data type | OBX-8 | OBX-11 |
|---|---|---|
| Value not in domain (Nres and Reserved) | OTH | X |
| Not a number | NAN | X |
| Positive infinity | PINF | X |
| Negative infinity | NINF | X |

When a special value is received there is no valid NM data type to represent the condition thus OBX-5 is set to empty.

### D.1.3.2 Case 2: Measurement contains a compound attribute

An observation containing a compound entry, which is always a numeric, is coded almost identically to an observation without a compound entry. The main difference is that the hierarchy is moved up one to the channel-level. Attributes that were previously coded as facets now appear at the metric level.

In a non-compound observation the type of the observation is given by the TYPE attribute or Metric-Id attribute. The partition for the Metric-Id attribute comes from the TYPE attribute unless there is a Metric-Id-Partition attribute.

In a compound attribute there are multiple elements. The overall observation type is given by the TYPE attribute, but the type of each compound element of the observation is given by the entries in the Metric-Id-List attribute in a one-to-one map. The partition for all entries in the Metric-Id-List attribute comes from the TYPE attribute unless there is a Metric-Id-Partition attribute. There is no means in [ISO/IEEE 11073-20601] to map a different partition to each nomenclature code in the Metric-Id-List.

The channel-level OBX is generated from the TYPE attribute, Label-String attribute and the chosen timestamp attribute. Each element of the compound attribute value is specified in its own OBX segment which is a child of the channel-level OBX. Any attribute that generated a facet OBX segment in the non-compound case also appears as a child OBX of the channel-level OBX. Thus, it appears at the same level as the compound-element OBX segments.

#### D.1.3.2.1 Channel-Level OBX

Every observation containing a compound attribute **shall** have a channel-level OBX segment as follows:

```
OBX|n||obx-3|m.0.c||||||X|||obx-14
```

where

– *obx-3* **shall** be the TYPE attribute value encoded as a CWE data type.

  o If the Label-String attribute is present it **shall** be entered in CWE-5 of OBX-3.

– *obx-14* **shall** be coded as described for OBX-14 in clause D.1.3.1.5 in the non-compound case.

Note that the value of X in OBX-11 even though the timestamp and the OBX-3 key value are important components of the overall observation and are needed to completely describe the observation. The reason for the 'X' value is that there is no OBX-5 field.

Example (Blood pressure):

```
OBX|n||150020^MDC_PRESS_BLD_NONINV^MDC |m.0.c||||||X|||20100108091005-0800
```

with a Label-String attribute:

```
OBX|n||150020^MDC_PRESS_BLD_NONINV^MDC^^Self-taken
measurement|m.0.c||||||X|||20100108091005-0800
```

Example (AMM Feedback):

```
OBX|n||8532995^MDC_AI_MED_FEEDBACK^MDC|m.0.c||||||X|||20101116091005-0500
```

#### D.1.3.2.2 Simple/Basic compound values OBX segments

The individual element values of the Compound-Simple-Nu-Observed-Value and Compound-Basic-Nu-Observed-Value attributes **shall** be encoded as a child of the channel-level OBX as follows:

```
OBX|n|NM|obx-3|m.0.c.x|obx-5|obx-6||obx-8|||obx-11
```

Note that there is no timestamp entry in these segments.

The *obx-3*, *obx-5*, *obx-6*, *obx-8* and *obx-11* fields shall be encoded according to the following subclauses.

##### D.1.3.2.2.1 obx-3 and obx-5

The Metric-Id-List and Metric-Id-Partition determine *obx-3* and Compound attribute determine *obx*-5.

The *obx*-3 entry **shall** be encoded as a CWE data type as follows:

– CWE-1 is computed from the nomenclature code obtained from the Metric-Id-List attribute value in a one-to-one map with the entries in the compound attribute where the partition code is obtained from
  - o the Metric-Id-Partition attribute value if present or
  - o the TYPE attribute value if the Metric-Id-Partition attribute is not present.
– CWE-2 is the corresponding reference-Id.
– CWE-3 is MDC.

The *obx-5* entry **shall** be taken from the corresponding entry in the compound attribute value in a one to one map with the Metric-Id-List attribute. If one of the compound entries is a special value *obx-5* **shall** be empty in that OBX segment and the *obx-8* and *obx-11* fields of that OBX segment **shall** be encoded as shown in clause D.1.3.1.4.2 for special values.

Table D.10 contains an example of blood pressure measurement that corresponds to the following encoding:

```
OBX|n|NM|150021^MDC_PRESS_BLD_NONINV_SYS^MDC|m.0.c.x|120|266016^MDC_DIM_MMHG^MDC|||||R
OBX|n+1|NM|150022^MDC_PRESS_BLD_NONINV_DIA^MDC|m.0.c.y|80|266016^MDC_DIM_MMHG^MDC|||||R
OBX|n+2|NM|150023^MDC_PRESS_BLD_NONINV_MEAN^MDC|m.0.c.z||266016^MDC_DIM_MMHG^MDC||NAN|||X
```

Table D.11 contains an example of AMM feedback measurement that corresponds to the following encoding:

```
OBX|n|NM|8532996^MDC_AI_MED_UF_LOCATION^MDC|m.0.c.x|3||||||R
OBX|n+1|NM|8532997^MDC_AI_MED_UF_RESPONSE^MDC|m.0.c.y|75||||||R
```

**Table D.10 – Example blood pressure**

| Entry # | Metric-Id-List entry value | Compound attribute entry value |
|---|---|---|
| 1 | `150021^MDC_PRESS_BLD_NONINV_SYS^MDC` | 120 |
| 2 | `150022^MDC_PRESS_BLD_NONINV_DIA^MDC` | 80 |
| 3 | `150023^MDC_PRESS_BLD_NONINV_MEAN^MDC` | NaN |

**Table D.11 – Example AMM feedback**

| Entry # | Metric-Id-List entry value | Compound attribute entry value |
|---|---|---|
| 1 | `8532996^MDC_AI_MED_UF_LOCATION^MDC` | 3 |
| 2 | `8532997^MDC_AI_MED_UF_RESPONSE^MDC` | 75 |

### D.1.3.2.2.2 obx-6

If the Unit-Code attribute is present

– *obx-6* **shall** be taken from the Unit-Code attribute value and coded as a CWE data type and placed in each OBX segment representing one of the compound observation parts.

– If the Unit-LabelString attribute is present its value **may** be placed in CWE-5 of the *obx-6* field in each case.

– Otherwise *obx-6* **shall** be empty.

Example:

```
OBX|n|NM|150021^MDC_PRESS_BLD_NONINV_SYS^MDC|m.0.c.x|120|266016^MDC_DIM_MMHG^MDC|||||R
OBX|n+1|NM|150022^MDC_PRESS_BLD_NONINV_DIA^MDC|m.0.c.y|80|266016^MDC_DIM_MMHG^MDC|||||R
OBX|n+2|NM|150023^MDC_PRESS_BLD_NONINV_MEAN^MDC|m.0.c.z|100|266016^MDC_DIM_MMHG^MDC|||||R
```

Example with Unit-LabelString:

```
OBX|n|NM|150021^MDC_PRESS_BLD_NONINV_SYS^MDC|m.0.c.x|120|266016^MDC_DIM_MMHG^MDC^^mm
Mercury|||||R
OBX|n+1|NM|150022^MDC_PRESS_BLD_NONINV_DIA^MDC|m.0.c.y|80|266016^MDC_DIM_MMHG^MDC^^mm
Mercury|||||R
OBX|n+2|NM|150023^MDC_PRESS_BLD_NONINV_MEAN^MDC|m.0.c.z|100|266016^MDC_DIM_MMHG^MDC^^mm
Mercury|||||R
```

Note that *obx-6* is the same in all three segments.

### D.1.3.2.2.3 obx-8 and obx-11

The Measurement-Status attribute values affect all elements of the compound. The encoding is identical to that of the non-compound case except the results are applied to all OBX segments representing the compound elements.

Example where a measurement status of 'measurement ongoing' is received:

```
OBX|n||8456149^MDC_HF_PIM^MDC^^Proportional Integral Mode
vector|m.0.c|||||||X|||20131108091005-0500
OBX|n+1|NM|8456150^MDC_HF_PIM_X^MDC|m.0.c.1|12.4|268768^MDC_DIM_CENTI_M_PER_SEC_SQ^MDC||BUSY||
|X
OBX|n+2|NM|8456151^MDC_HF_PIM_Y^MDC|m.0.c.2|8800.0|268768^MDC_DIM_CENTI_M_PER_SEC_SQ^MDC||BUSY
|||X
OBX|n+3|NM|8456152^MDC_HF_PIM_Z^MDC|m.0.c.3|9.5|268768^MDC_DIM_CENTI_M_PER_SEC_SQ^MDC||BUSY|||
X
```

Example where a measurement status of 'measurement ongoing' is received and a NaN is received in one of the compound elements:

```
OBX|n||8456149^MDC_HF_PIM^MDC^^Proportional Integral Mode
vector|m.0.c|||||||X|||20131108091005-0500
```

```
OBX|n+1|NM|8456150^MDC_HF_PIM_X^MDC|m.0.c.1|12.4|268768^MDC_DIM_CENTI_M_PER_SEC_SQ^MDC||BUSY||
|X
OBX|n+2|NM|8456151^MDC_HF_PIM_Y^MDC|m.0.c.2|8800.0|268768^MDC_DIM_CENTI_M_PER_SEC_SQ^MDC||BUSY
|||X
OBX|n+3|NM|8456152^MDC_HF_PIM_Z^MDC|m.0.c.3||268768^MDC_DIM_CENTI_M_PER_SEC_SQ^MDC||NAN~BUSY||
|X
```

#### D.1.3.2.3 Compound-Nu-Observed-Value attribute

If the observation contains a Compound-Nu-Observed-Value attribute the Unit-Code, Metric-Id-List, Measurement-Status and Unit-Label-String attributes of the metric object are ignored. These attributes **shall**, instead, be obtained from their equivalents within the ASN.1-Nu-Observed-Value structure *for each entry*. The ASN.1-metric-id struct in each ASN.1-Nu-Observed-Value struct replaces the entries that would have been present in the Metric-Id-List attribute.

Recall that the use of this compound attribute in [ISO/IEEE 11073-20601] indicates that these entries, each with a different possible unit and type, *are not independent observations but part of a single observation*. A possible example to illustrate this concept would be a sensor that measures the 3-d acceleration using different units for the x, y and z components, perhaps because the units are orders of magnitude different in the different directions. The Compound-Nu-Observed-Value attribute would contain three Nu-Observed-Value structs, where the ASN.1-metric-id entry would indicate the component (x, y, or z) and the ASN.1-unit-code entry the units. The resultant set of OBX segments might appear as follows:

```
OBX|n||8456149^MDC_HF_PIM^MDC^^Proportional Integral Mode
vector|m.0.c||||||X|||20131108091005-0500
OBX|n+1|NM|8456150^MDC_HF_PIM_X^MDC|m.0.c.1|12.4|268768^MDC_DIM_CENTI_M_PER_SEC_SQ^MDC||||R
OBX|n+2|NM|8456151^MDC_HF_PIM_Y^MDC|m.0.c.2|88.0|268751^MDC_DIM_M_PER_SEC_SQ^MDC||||R
OBX|n+3|NM|8456152^MDC_HF_PIM_Z^MDC|m.0.c.3|10.0|268768^MDC_DIM_CENTI_M_PER_SEC_SQ^MDC||||R
```

#### D.1.3.2.4 'Facet' OBX segments

The Supplemental types, Source-Handle-Reference, Source-Handle-Reference-List, Accuracy, and Measurement-Active-Period attributes are encoded exactly as in the non-compound case except the hierarchy is moved up one level so that they are children of the channel-level OBX segment AND the OBX-11 value is set to R; it does NOT inherit the OBX-11 value of the parent. These segments are now at the metric-level instead of the facet level.

Example where a Supplemental types attribute indicating a SPOT observation is present:

```
OBX|n||8456149^MDC_HF_PIM^MDC^^Proportional Integral Mode
vector|m.0.c||||||X|||20131108091005-0500
OBX|n+1|NM|8456150^MDC_HF_PIM_X^MDC|m.0.c.1|12.4|268768^MDC_DIM_CENTI_M_PER_SEC_SQ^MDC||||R
OBX|n+2|NM|8456151^MDC_HF_PIM_Y^MDC|m.0.c.2|8800.0|268768^MDC_DIM_CENTI_M_PER_SEC_SQ^MDC|||||
R
OBX|n+3|NM|8456152^MDC_HF_PIM_Z^MDC|m.0.c.3|10.0|268768^MDC_DIM_CENTI_M_PER_SEC_SQ^MDC||||R
OBX|n+4|CWE|68193^MDC_ATTR_SUPPLEMENTAL_TYPES^MDC|m.0.c.4|150588^MDC_MODALITY_SPOT^MDC|||||R
```

### D.1.4 Special situations

#### D.1.4.1 Time discontinuities: Date-Time-Adjustments

[IHE PCD-01] requires that the timeline remain unbroken. If there is a discontinuity in the timeline, a new OBR segment is required. With [ISO/IEEE 11073-20601] sensors this situation is indicated by the presence of a Date-Time-Adjustment attribute. A PHG can receive this attribute in scan-event reports or it may be in the list of attributes describing a PM segment. In either case, the PHG is required to create a new OBR segment for the observation data affected by the Date-Time-Adjustment attribute. When creating a new OBR segment a new set of MDS-OBXes is required. If only the required attributes of the MDS are recorded, a new GET request is not needed since all the attribute values are static except for the coincident timestamps. If the date-time-adjustment occurs in agent-init scan event reports (live data), all the PHG needs to do is update the coincident time stamp OBX by adding to OBX-5 the date-time-adjustment value. For example, if the date-time-adjustment value is 50 minutes, the clock now being used by the sensor is 50 minutes ahead of what it was. OBX-5 in the updated coincident timestamp OBX can be generated by adding 50 minutes to the OBX-5 value in the original coincident timestamp OBX.

If, however, the date-time-adjustment is in a PM segment attribute, the sensor's clock is *already* on the new timeline and the existing coincident timestamp OBX is for that current clock. In this case the PHG needs to generate a coincident timestamp that would have been generated if the sensor had not updated it clock. The PHG can do this task by adjusting the sensor's contribution to the existing coincident timestamp OBX by subtracting the date-time-adjustment value from OBX-5. For example, if the OBX-5 value the existing coincident timestamp OBX is 20140510092232 and the date-time-adjustment value in the PM-Segment Date-Time-Adjustment attribute is 72 minutes, that indicates the current clock is 72 minutes ahead of what it was prior to the change. Thus one subtracts the 72 minutes from OBX-5 to get the time the clock would have had if no time change were made making OBX-5 equal to 20140510092120.

#### D.1.4.2 OBX-20 replacing OBX-5

In the original version of this standard when an Enum-Observed-Value-Partition attribute was received, the encoded value of the respective Enum OID attribute was placed in OBX-20 and not OBX-5. The value **shall** now be placed in OBX-5. The only time OBX-20 is filled is if there is a value in OBX-5; in other words it is supplementary information.

#### D.1.4.3 Stored and live observations

If a sensor device has stored data and also sends live data, the implementor *may* Servicest to put these observations in separate OBRs. However, separate OBRs are not required unless the observations are on different time lines.

#### D.1.4.4 Multiple devices

An association from a different device is treated just like any new association. One can place the new association in a new OBR or create a new MDS level n-tuple in the same OBR. There is no relation between the OBR sequence number and the MDS level n-tuple value.

#### D.1.4.5 Observations with and without timestamps

[ISO/IEEE 11073-20601] allows a sensor to send observations with and without timestamps in the same association. An example would be a pulse oximeter sending specialization configuration 0x190 observations ('streamed' $SpO_2$ and Pulse Rate values with no timestamp) and occasional SPOT observations from specialization configuration 0x191 with timestamps in an extended configuration. In the versions prior to these design guidelines this situation did not pose a problem since the PHG always corrected the sensor's timestamps or provided one on the sensor's behalf. In this version of the standard the sensor timestamps may be used without correction. If that sensor also sent observations without timestamps there would be no way to tell that those timestamps are provided by the PHG. The current solution is to place the sensor timestamped observations in one OBR and the PHG timestamped observations in a separate OBR.

#### D.1.4.6 Bluetooth low energy considerations

Given the Transcoding White Paper [Bluetooth PHDT] it might appear that transcoding is an essential step in the mapping of Bluetooth low energy (Bluetooth LE) sensor data to a PDC-01 document. At face value transcoding is costly. However, this step is not necessary. The mapping of Bluetooth LE data to OBX segments is refreshingly simple. The characteristic value attributes typically arrive with all context information. All that is needed is to decode the bytes into their specified values and place these values directly into the respective fields of the OBX segment. The specialization being handled pre-determines the majority of the nomenclature codes.

As an example consider the temperature measurement characteristic received by indication. The characteristic is a string of bytes containing a 1-byte flags setting, followed by a 4-byte ASN.1 FLOAT temperature value, followed by an optional 7-byte timestamp, followed by an optional 1-byte temperature type field. The flags indicate whether or not the temperature value is in centigrade or fahrenheit, whether or not there is a timestamp, and whether or not there is a type field. This characteristic maps directly to a Metric-OBX and provides all the information needed to fill the mandatory fields. In this case:

– OBX-2 is NM since the data type is a float.

– OBX-3 is obtained from the Transcoding White Paper [Bluetooth PHDT]; for a the Thermometer specialization it is MDC_TEMP_BODY if there is no temperature type field or if there is a temperature type field it is one of the values indicated in Table D.12 depending upon the value of the temperature type. The partition is MDC_PART_SCADA (2) in all cases. From these values OBX-3 can be encoded into its CWE data type:

**Table D.12 – Bluetooth LE temperature location codes**

| 11073-10408<br>Temperature nomenclature code | Temperature type description | Temperature type |
|---|---|---|
| MDC_TEMP_AXILLA | Armpit | 0x01 |
| MDC_TEMP_BODY | Body (general) | 0x02 |
| MDC_TEMP_EAR | Ear (usually ear lobe) | 0x03 |
| MDC_TEMP_FINGER | Finger | 0x04 |
| MDC_TEMP_GIT | Gastro-intestinal Tract | 0x05 |
| MDC_TEMP_ORAL | Mouth | 0x06 |
| MDC_TEMP_RECT | Rectum | 0x07 |
| MDC_TEMP_TOE | Toe | 0x08 |
| MDC_TEMP_TYMP | Tympanum (ear drum) | 0x09 |
| | Reserved | All other values |

– OBX-5 is the value obtained from the 4-byte ASN.1 FLOAT.

– OBX-6 is either MDC_DIM_DEGC or MDC_DIM_FAHR, depending upon the flags setting, encoded as a CWE data type.

– OBX-11 is R.

– OBX-14 is obtained from the timestamp (if present). The 7-byte timestamp is formatted as YYYYMMDDHHMMSS. There is no hundredths and it is local. Just as in the [ISO/IEEE 11073-20601] case, one needs to have previously obtained the coincident timestamp via a time characteristic or the current time service to perform any translations. At this time, case 1 and case 3 are the only relevant cases for Bluetooth LE sensors.

If the value of the float is a special value, OBX-8 and OBX-11 are affected according to clause D.1.3.1.4.2.

### D.1.4.7 Differences from [IHE PCD-01]

There are differences between the Continua guidelines and [IHE PCD-01]. They are noted here.

– [IHE PCD-01] states that OBX-5 is empty if OBX-11 is 'X'. In these guidelines, that situation is only true if the OBX-5 value is one of the special values (NaN, +Inf, etc.).

– [IHE PCD-01] requires that CWE-2 be non-empty. In these guidelines, CWE-2 may be empty but CWE-1 is always non-empty.

– [IHE PCD-01] requires the existence of a coincident timestamp pair if the sensor reports a timestamp. In these guidelines, no coincident timestamp pair is reported if the PHG does not translate the sensor times (case #2).

### D.1.4.8 Examples

#### D.1.4.8.1 Advanced medication monitor

Below is a PCD-01 document created from an association with an advanced medication monitor supporting a dispensing of a fixed amount of medicine, a question/answer user feedback object, and a status object. The PHG supports soap Observation Upload, capability exchange and authenticated persistent sessions. Sensor supports USB, Bluetooth, ZigBee and Continua 1.0.

```
MSH|^~\&|0xFEEDABEEBEADDEEF||||20140510092236.770-0400||ORU^R01^ORU_R01|1|P|2.6|||NE|AL|||||IHE PCD
ORU-R012006^HL7^2.16.840.1.113883.9.n.m^HL7
PID|||28da0026bc42484^^^1.19.6.24.109.42.1.3^PI||Landstrom^Goran^L.^Sr.^Dr.^PhD^L^^L
OBR|1|LNI_PHG^LNI MOXP PHG^0xFEEDABEEBEADDEEF^EUI-64|LNI_PHG^LNI MOXP PHG^0xFEEDABEEBEADDEEF^EUI-
64|182777000^monitoring of patient^SNOMED-CT|||20140510092237.061-0400|20140510092236.776-0400
OBX|1||531981^MDC_MOC_VMS_MDS_PHG^MDC|0|||||||X|||||||0xFEEDABEEBEADDEEF^^0xFEEDABEEBEADDEEF^EUI-64
OBX|2|CWE|68218^MDC_REG_CERT_DATA_AUTH_BODY^MDC|0.0.0.1|2^auth-body-continua||||||R
OBX|3|ST|532352^MDC_REG_CERT_DATA_CONTINUA_VERSION^MDC|0.0.0.1.1|5.0||||||R
OBX|4|NM|532353^MDC_REG_CERT_DATA_CONTINUA_CERT_DEV_LIST^MDC|0.0.0.1.2|28676||||||R
OBX|5|CWE|68218^MDC_REG_CERT_DATA_AUTH_BODY^MDC|0.0.0.2|2^auth-body-continua||||||R
OBX|6|CWE|532354^MDC_REG_CERT_DATA_CONTINUA_REG_STATUS^MDC|0.0.0.2.1|1^unregulated(0)||||||R
OBX|7|CWE|68218^MDC_REG_CERT_DATA_AUTH_BODY^MDC|0.0.0.3|2^auth-body-continua||||||R
OBX|8|CWE|532355^MDC_REG_CERT_DATA_CONTINUA_PHG_CERT_LIST^MDC|0.0.0.3.1|0^observation-upload-
soap~2^capability-exchange~6^aps||||||R
OBX|9|CWE|68220^MDC_TIME_SYNC_PROTOCOL^MDC|0.0.0.4|532234^MDC_TIME_SYNC_EBWW^MDC||||||R
OBX|10||528456^MDC_DEV_SPEC_PROFILE_AI_MED_MINDER^MDC|1|||||||X|||||||21d60149fad418^^21d60149fad418
^EUI-64
OBX|11|ST|531970^MDC_ID_MODEL_MANUFACTURER^MDC|1.0.0.1|Medication Monitor Manufacturers||||||R
OBX|12|ST|531969^MDC_ID_MODEL_NUMBER^MDC|1.0.0.2|Clinical Trial 0002||||||R
OBX|13|ST|531972^MDC_ID_PROD_SPEC_SERIAL^MDC|1.0.0.3|1203ARF33342||||||R|||||||0^PrivateOID^21d60149
fad418^EUI-64
OBX|14|ST|531976^MDC_ID_PROD_SPEC_FW^MDC|1.0.0.4|Revision14.5||||||R|||||||0^PrivateOID^21d60149fad4
18^EUI-64
OBX|15|CWE|68218^MDC_ATTR_REG_CERT_DATA_AUTH_BODY^MDC|1.0.0.5|2^auth-body-continua||||||R
OBX|16|ST|532352^MDC_REG_CERT_DATA_CONTINUA_VERSION^MDC|1.0.0.5.1|5.0||||||R
OBX|17|NM|532353^MDC_REG_CERT_DATA_CONTINUA_CERT_DEV_LIST^MDC|1.0.0.5.2|72~8264~16456~24648||||||R
OBX|18|CWE|68218^MDC_ ATTR_REG_CERT_DATA_AUTH_BODY^MDC|1.0.0.6|2^auth-body-continua||||||R
OBX|19|CWE|532354^MDC_REG_CERT_DATA_CONTINUA_REG_STATUS^MDC|1.0.0.6.1|1^unregulated(0)||||||R
OBX|20|CWE|67925^MDC_ATTR_POWER_STAT^MDC|1.0.0.7|1^onMains(0)||||||R
OBX|21|CWE|68219^MDC_TIME_CAP_STATE^MDC|1.0.0.8|1^mds-time-capab-real-time-clock(0)~1^mds-time-
capab-set-clock(1)~1^mds-time-capab-relative-time(2)~1^mds-time-mgr-set-time(11)||||||R
OBX|22|CWE|68220^MDC_TIME_SYNC_PROTOCOL^MDC|1.0.0.9|532224^MDC_TIME_SYNC_NONE^MDC||||||R
OBX|23|NM|68222^MDC_TIME_RES_ABS^MDC|1.0.0.10|1000000|264339^MDC_DIM_MICRO_SEC^MDC|||||R
OBX|24|DTM|67975^MDC_ATTR_TIME_ABS^MDC|1.0.0.11|20140510092232||||||R|||20140510092234.061-0400
OBX|25|NM|67983^MDC_ATTR_TIME_REL^MDC|1.0.0.12|2000000|264339^MDC_DIM_MICRO_SEC^MDC|||||R|||20140510
092234.061-0400
OBX|26|NM|8532992^MDC_AI_MED_DISPENSED_FIXED^MDC|1.0.0.13|4||||||R|||20140510092237.061-0400
OBX|27||8532995^MDC_AI_MED_FEEDBACK^MDC|1.0.1|||||||X|||20140510092237.061-0400
OBX|28|NM|8532996^MDC_AI_MED_UF_LOCATION^MDC|1.0.1.1|1||||||R
OBX|29|NM|8532996^MDC_AI_MED_UF_LOCATION^MDC|1.0.1.2|0||||||R
OBX|30||8532995^MDC_AI_MED_FEEDBACK^MDC|1.0.2|||||||X|||20140510092237.061-0400
OBX|31|NM|8532996^MDC_AI_MED_UF_LOCATION^MDC|1.0.2.1|2||||||R
OBX|32|NM|8532996^MDC_AI_MED_UF_LOCATION^MDC|1.0.2.2|1||||||R
OBX|33||8532995^MDC_AI_MED_FEEDBACK^MDC|1.0.3|||||||X|||20140510092237.061-0400
OBX|34|NM|8532996^MDC_AI_MED_UF_LOCATION^MDC|1.0.3.1|3||||||R
OBX|35|NM|8532996^MDC_AI_MED_UF_LOCATION^MDC|1.0.3.2|0||||||R
OBX|36||8532995^MDC_AI_MED_FEEDBACK^MDC|1.0.4|||||||X|||20140510092237.061-0400
OBX|37|NM|8532996^MDC_AI_MED_UF_LOCATION^MDC|1.0.4.1|4||||||R
OBX|38|NM|8532996^MDC_AI_MED_UF_LOCATION^MDC|1.0.4.2|1||||||R
OBX|39|CWE|8532994^MDC_AI_MED_STATUS^MDC|1.0.0.14|1^medication-course-
complete(4)||||||R|||20140510092237.061-0400
```

### D.1.4.8.2 Pulse oximeter with scale

This sensor supports two specializations and thus reports hydra at the top level.

```
MSH|^~\&|0xFEEDABEEBEADDEEF||||20140510094932.815-0400||ORU^R01^ORU_R01|5|P|2.6|||NE|AL|||||IHE PCD
ORU-R012006^HL7^2.16.840.1.113883.9.n.m^HL7
PID|||28da0026bc42484^^^1.19.6.24.109.42.1.3^PI||Landstrom^Goran^L.^Sr.^Dr.^PhD^L^^L
OBR|1|LNI_PHG^LNI MOXP PHG^0xFEEDABEEBEADDEEF^EUI-64|LNI_PHG^LNI MOXP PHG^0xFEEDABEEBEADDEEF^EUI-
64|182777000^monitoring of patient^SNOMED-CT|||20140510094931.835-0400|20140510094932.815-0400
OBX|1||531981^MDC_MOC_VMS_MDS_PHG^MDC|0|||||||X|||||||0xFEEDABEEBEADDEEF^^0xFEEDABEEBEADDEEF^EUI-64
Several PHG-OBXes
OBX|10||528384^MDC_DEV_SPEC_PROFILE_HYRDA^MDC|1|||||||X|||||||21d60149fad418^^21d60149fad418^EUI-64
OBX|11|CWE|68186^MDC_ATTR_SYS_TYPE_SPEC_LIST^MDC|1.0.0.1|528388^MDC_DEV_SPEC_PROFILE_PULS_OXIM^MDC~5
28399^MDC_DEV_SPEC_PROFILE_SCALE^MDC||||||R
OBX|12|ST|531970^MDC_ID_MODEL_MANUFACTURER^MDC|1.0.0.2| MultiSensor ModelPOWS||||||R
OBX|13|ST|531969^MDC_ID_MODEL_NUMBER^MDC|1.0.0.3|MultiSensor002||||||R
OBX|14|ST|531972^MDC_ID_PROD_SPEC_SERIAL^MDC|1.0.0.4|1203ARF33342||||||R|||||||0^PrivateOID^21d60149
fad418^EUI-64
OBX|15|ST|531976^MDC_ID_PROD_SPEC_FW^MDC|1.0.0.5|Rev14.5||||||R|||||||0^PrivateOID^21d60149fad418^EU
I-64
OBX|16|CWE|68218^MDC_ ATTR_REG_CERT_DATA_AUTH_BODY^MDC|1.0.0.6|2^auth-body-continua||||||R
OBX|17|ST|532352^MDC_REG_CERT_DATA_CONTINUA_VERSION^MDC|1.0.0.6.1|5.0||||||R
OBX|18|NM|532353^MDC_REG_CERT_DATA_CONTINUA_CERT_DEV_LIST^MDC|1.0.0.6.2|4~8196~16388~24580~15~8207~1
6399~24591||||||R
OBX|19|CWE|68218^MDC_ ATTR_REG_CERT_DATA_AUTH_BODY^MDC|1.0.0.7|2^auth-body-continua||||||R
OBX|20|CWE|532354^MDC_REG_CERT_DATA_CONTINUA_REG_STATUS^MDC|1.0.0.7.1|1^unregulated(0)||||||R
OBX|21|CWE|67925^MDC_ATTR_POWER_STAT^MDC|1.0.0.8|1^onMains(0)||||||R
OBX|22|CWE|68219^MDC_TIME_CAP_STATE^MDC|1.0.0.9|1^mds-time-capab-real-time-clock(0)~1^mds-time-
capab-set-clock(1)~1^mds-time-capab-relative-time(2)~1^mds-time-mgr-set-time(11)||||||R
OBX|23|CWE|68220^MDC_TIME_SYNC_PROTOCOL^MDC|1.0.0.10|532224^MDC_TIME_SYNC_NONE^MDC||||||R
OBX|24|NM|68222^MDC_TIME_RES_ABS^MDC|1.0.0.11|1000000|264339^MDC_DIM_MICRO_SEC^MDC|||||R
OBX|25|DTM|67975^MDC_ATTR_TIME_ABS^MDC|1.0.0.12|20140510094930||||||R|||20140510094930.835-0400
OBX|26|NM|67983^MDC_ATTR_TIME_REL^MDC|1.0.0.13|2000000|264339^MDC_DIM_MICRO_SEC^MDC|||||R|||20140510
094930.835-0400
OBX|27|NM|150456^MDC_PULS_OXIM_SAT_O2^MDC|1.0.0.14|87.5|262688^MDC_DIM_PERCENT^MDC|||||R|||201405100
94931.835-0400
OBX|28|NM|188736^MDC_MASS_BODY_ACTUAL^MDC|1.0.0.15|91.8423|263875^MDC_DIM_KILO_G^MDC|||||R|||2014051
0094931.835-0400
OBX|29|NM|149530^MDC_PULS_OXIM_PULS_RATE^MDC|1.0.0.16|75.8|264864^MDC_DIM_BEAT_PER_MIN^MDC|||||R|||2
0140510094931.835-0400
```

## D.1.5 Timestamping and time synchronization

Timestamps associated with observations sent over the Continua services shall be referenced to a single consistent Coordinated Universal Time (UTC) timeline to facilitate accurate correlation and processing. Ideally, the timestamps should include the local time offset where the observations were made to facilitate correlation with manual records maintained by the patient and caregivers.

Since many personal health devices have only a sense of internal time, and this internal time may not be equivalent to the UTC and local time maintained by the PHG, the Continua services interface requires the ability to report a coincident timestamp pair. The coincident timestamp pair is formed by capturing the current time from both the device and the PHG as close to simultaneously as is reasonably possible. This capture establishes the time relationship between the PHG and the device's internal time and allows the PHG to report device observations on the UTC timeline.

NOTE – The coincident timestamp pair allows the services receiver to display and record the original device time and the PHG UTC time in the case where the PHG translates timestamps. The coincident timestamp pair can also support an audit of the original timestamps provided by the personal health device.

Three types of timestamps are defined:

– **Qualified time**: A "qualified time" expresses a unique time point along the coordinated universal time (UTC) timescale that is the primary time standard by which the world regulates clocks and time.

  Qualified time is expressed as an HL7 V2 "DTM" datatype and must include the time zone offset, expressed either as ±ZZZZ (HHMM) if the civil time zone offset is known or −0000 if UTC time (e.g., derived from NTP) is known but the actual civil time zone offset is not. Note that the unknown civil time zone (−0000) is a DG2015 extension to the formal definition of 'qualified time' which includes the civil time zone. The qualified time syntax is:

- o **YYYYMMDDHHMMSS**[.S[S[S[S]]]]**±ZZZZ** if civil time zone offset ±ZZZZ is known.
- o **YYYYMMDDHHMMSS**[.S[S[S[S]]]]**−−0000** if UTC time is known but civil time zone is not.

Table D.13 contains examples of qualified time timestamps.

**Table D.13 – Qualified time timestamp examples**

| Example | Description |
|---|---|
| `|19760104010123-0500|` | 1:01:23 AM on 4 January 1976 in the Eastern Standard Time zone (USA) |
| `|19760704010123-0400|` | 1:01:23 AM on 4 July 1976 in the Eastern Daylight Saving Time zone (USA). |
| `|19760704010523-0000|` | 1:01:23 AM on 4 July 1976, Eastern Daylight Saving Time, expressed as UTC. |
| `|20130722162400+0100|` | 4:24:00 PM on 22 July 2013, British Summer Time (BST) (Prince George birth) |
| `|20131122162400+0000|` | 4:24:00 PM on 22 November 2013, Greenwich Mean Time (GMT) |
| `|20131122162400-0000|` | 4:24:00 PM on 22 November 2013 in London, but expressed as UTC. |
| `|20131123012400+0900|` | The same time-point, expressed with Tokyo local time-zone offset (on the next day) |

– **unqualified local time**: the syntax is **YYYYMMDDHHMMSS**[.S[S[S[S]]]], where the time zone offset is omitted: the civil time zone offset and UTC time are both unknown.

– **synchronized:** a qualified timestamp that is accurate within predefined limits that shall not exceed 5 minutes **DTM*PHG***: HL7 V2 'DTM' timestamps sent by the PHG in **MSH-7**, **OBR-7**, **OBR-8** and **OBX-14**. These represent the time that will be used by the Services receiver and other enterprise applications.

Note that qualified time does not imply accuracy; it simply means that the time reported is on the UTC time line with local offset (which may also be expressed as −0000). Accuracy comes from synchronization and the degree of accuracy is determined by the method and source of synchronization.

To ensure the highest level of interoperability, it is **strongly recommended** that **DTM*PHG*** timestamps use **qualified time** to express a unique timepoint on the UTC timescale. Ideally, the actual civil time zone offset ±ZZZZ **should** be used; otherwise, the time zone −0000 may be specified to indicate UTC time. Continua services Observation Upload devices **shall** be capable of being synchronized to a reference time source such as NTP, CDMA, GSM NITZ or other source of reference time. In certain cases (and only as a last resort) unqualified local time may be conveyed by a DTM*PHG* timestamp.[1]

[1] Note that in order for an AHD it shall be capable of being synchronized to an external time source.

### D.1.5.1 PHG clock and synchronization

Information regarding the PHG clock and PHG synchronization state are described in Table D.14. By convention, information describing the PHG clock is conveyed by MDS level 0 in OBX-4.

**Table D.14 – PHG time elements**

| Msg segment (Note 1) | Description and comments | Q (Note 2) |
|---|---|---|
| MSH | MSH-7 Date/Time of Message created/sent ($DTM_{PHG}$) | M |
| PID | | M |
| OBR | [OBR-7, OBR-8) Default time interval for child OBXs ($DTM_{PHG}$) | M |
| OBX 0 | PHG | M |
| OBX 0.0.0.1 | MDC_TIME_SYNC_PROTOCOL (OBX-5 specifies the time sync protocol of the PHG; see Table D.19 for the list of valid synchronization profiles) | M |
| OBX 0.0.0.2 | MDC_TIME_SYNC_ACCURACY (OBX-5 specifies the known or estimated accuracy of $DTM_{PHG}$ time, relative to a reference time source such as NTP) | O |
| OBX 0.0.0.3 | MDC_ATTR_TIME_REL (OBX-5 specifies the relative timestamp value, OBX-14 specifies the corresponding $DTM_{PHG}$, and OBX-18 specifies the unique identity of the timebase provided by the PHG) | C |
| OBX 0.0.0.4 | MDC_TIME_RES_REL (OBX-5 specifies the resolution of the relative clock) | O |
| OBX 0.0.0.5 | MDC_ATTR_TIME_REL_HI_RES (OBX-5 specifies the hi-res relative timestamp value, OBX-14 specifies the corresponding $DTM_{PHG}$, and OBX-18 specifies the unique identity of the timebase provided by the PHG) | C |
| OBX 0.0.0.6 | MDC_TIME_REL_HI_RES (OBX-5 specifies the resolution of the hi-res relative clock) | O |
| NOTE 1 – The dotted numbers represent the object hierarchy value of OBX-4 and are provided as example values only, except for MDS level 0 which is reserved for observations about the PHG itself.<br>NOTE 2 – Column Q denotes the presence qualifier: M: mandatory, O: option, C: conditional. | | |

The mandatory MDC_TIME_SYNC_PROTOCOL attribute specifies the time sync protocol used by the PHG, drawing from the list of enumerated values listed in Table D.19.

The optional MDC_TIME_SYNC_ACCURACY attribute specifies the estimated accuracy of timestamps sent by the PHG. It is defined as the maximum error of the PHG clock relative to a primary reference clock source such as a NTP, cellular, etc., in seconds. The accuracy is encoded as positive decimal number of seconds (e.g., '10.,' '5.,' '0.5,' etc.) or some other scaled unit such as microseconds using the HL7 V2 'NM' datatype and **shall** include an estimate of the cumulative error due to clock drift since the PHG clock was last synchronized.

NOTE – The accuracy of PHG clocks that are synchronized by the Internet 'Network Time Protocol' [IETF RFC 1305) or 'Simple Network Time Protocol' (IETF RFC 2030) can be estimated using the following relationship: MDC_TIME_SYNC_ACCURACY = 'root dispersion' + ½ 'root delay' + the cumulative clock drift (typically 20 ppm times the elapsed time since the PHG had last synchronized to NTP). Alternative estimates for accuracy may be used if other synchronization protocols or methods are employed. MDC_TIME_SYNC_ACCURACY shall not be reported, however, if the PHG's clock has not been synchronized to a reference source of time.

If MDC_TIME_SYNC_ACCURACY is unknown or exceeds five minutes, MDC_TIME_SYNC_PROTOCOL **shall** be set to MDC_TIME_SYNC_NONE to indicate an uncalibrated and unsynchronized local clock.

### D.1.5.1.1 PHG provides relative time synchronization services to sensors

If the PHG provides a common relative or high-resolution relative clock service to devices, it **shall** include MDC_ATTR_TIME_REL or MDC_ATTR_TIME_REL_HI_RES attribute containing a unique identifier string in OBX-18, described in Table D.18. If the time synchronization between the relative or high-resolution relative clock reported in OBX-5 is known relative to UTC, it shall be disclosed in OBX-14 (this is an example of a coincident timestamp pair where the comparison is between the relative time clock and the UTC-based time clock of the PHG; a coincident time relation between the PHG and the sensor is provided indirectly since the PHG is controlling the sensor's relative time clock). The MDC_TIME_RES_REL and MDC_TIME_REL_HI_RES attributes specify the resolution of the relative and hi-res relative clocks, respectively; if omitted, the default resolution of 125 μs and 1 μs shall be assumed.

### D.1.5.2 Sensor clocks and synchronization

Information regarding the sensor clocks and sensor observations are described in Table D.15.

The default time interval for all measurements is specified by [OBR-7, OBR-8) of the containing OBR message segment. A time that falls within this interval can be explicitly specified by a $DTM_{PHG}$ time point value specified by OBX-14 at the CHAN, METRIC, FACET or SUBFACET levels. Every OBX-14 timestamp value must be within the interval [OBR-7, OBR-8) specified by the containing OBR.

**Table D.15 – Sensor time elements**

| Msg segment | Description and comments | Q |
|---|---|---|
| `OBR.` | [OBR-7, OBR-8) Default time interval for child OBXs ($DTM_{PHG}$) | M |
| `OBX.. 1` | MDS for device #1 | M |
| `OBX.. 1.0.0.1` | MDC_TIME_CAP_STATE (BITS-16, using MdsTimeCapState obtained from Mds-Time-Info) | C |
| `OBX.. 1.0.0.2` | MDC_TIME_SYNC_PROTOCOL (obtained from Mds-Time-Info) | O |
| `OBX.. 1.0.0.3` | MDC_TIME_SYNC_ACCURACY (sensor absolute or base-offset time accuracy obtained from Mds-Time-Info) | O |
| `OBX.. 1.0.0.4` | MDC_ATTR_TIME_ABS (OBX-5 specifies the unqualified displayed time and OBX-14 specifies the corresponding $DTM_{PHG}$) | C |
| `OBX.. 1.0.0.5` | MDC_ATTR_TIME_BO (OBX-5 specifies the qualified displayed time and time zone offset and OBX-14 specifies the corresponding $DTM_{PHG}$) | |
| `OBX.. 1.0.0.6` | MDC_ATTR_TIME_REL (OBX-5 specifies the relative timestamp value, OBX-14 specifies the corresponding $DTM_{PHG}$, and OBX-18, if present, specifies the unique identity of the timebase*) | |
| `OBX.. 1.0.0.7` | MDC_TIME_RES_REL (OBX-5 specifies the resolution of the relative clock and OBX-18, if present, specifies the unique identity of the timebase*) Time resolution obtained from Mds-Time-Info | |
| `OBX.. 1.0.0.8` | MDC_ATTR_TIME_REL_HI_RES (OBX-5 specifies the hi-res relative timestamp value, OBX-14 specifies the corresponding $DTM_{PHG}$, and OBX-18, if present, specifies the unique identity of the timebase*) | |

**Table D.15 – Sensor time elements**

| Msg segment | Description and comments | Q |
|---|---|---|
| `OBX.. 1.0.0.9` | MDC_TIME_RES_REL_HI_RES (OBX-5 specifies the resolution of the hi-res relative clock, and OBX-18, if present, specifies the unique identity of the timebase) Time resolution from Mds-Time-Info | |
| `OBX.. 1.0.N.M` | For any observation, OBX-14 $DTM_{PHG}$ may be *optionally* valued with a timepoint that overrides the default [OBR-7, OBR-8)] time interval of the containing OBR | |
| `OBR.` | [OBR-7, OBR-8) Default time interval for child OBXs ($DTM_{PHG}$) | O |
| `OBX.. 2` | MDS for device #2 | M |

NOTE – Information for OBX-18 must be obtained out of band (it is not provided via the ISO/IEEE 11073-20601 exchanges).

Notes for Table D.14 and Table D.15:

a. The conversion of sensor time to DTM PHG may introduce a rounding error of the fractional component due to the conversion of the original binary fractional component expressed in units of 1/65536th of a second to a decimal fraction that is limited to 1/10000th of a second.

b. Within the time scope of each MDS object, time discontinuities in the MDC_ATTR_TIME_ABS displayed time are prohibited. Discontinuities due to daylight savings or other clock adjustments require data on the new displayed timeline be sent under a separate MDS or within a separate message. Since the Base component of the Base Offset time is never discontinuous by definition, any discontinuity is expressed by the offset ±ZZZZ. Thus the PHG will not have a problem providing a consistent time base in OBX-14 and it is not necessary to perform the above steps when the offset value changes.

c. OBR-7 and OBR-8 establish the default time context for all OBXs within the scope of the containing OBR. If only OBR-7 is specified, the default time context is a time point; if OBR-7 and OBR-8 are both specified, it is a time interval. The default time context can be overridden by a timestamp (representing a point in time) in OBX-14 at the CHAN, METRIC, FACET or SUBFACET levels. Since these guidelines require an OBX-14 entry for all observation OBX segments, the default time context is always overridden. However, OBR-7 and OBR-8 provide the time range for informational purposes.

d. The time interval specified by [OBR-7, OBR-8) is a mathematically 'closed' interval for OBR-7 and 'open' for OBR-8. A datum that occurs exactly at the time specified by OBR-8 would be sent in the next time epoch. This allows subsequent OBR segments to represent a continuous sequence of time. For encoding a simple set of episodic measurement, if there is no logical "end" of the observation period, OBR-8 can be set to the message creation time as a logical upper limit for the contained observations

The time information above is provided for each sensor (MDS-level) and is conveyed at the METRIC level in OBX-4, prior to any sensor observations. There are three cases to consider: the first where the PHG translates the original sensor timestamps to the UTC timeline; the second, where the original sensor absolute or base-offset timestamps are reported without translation; and third, the sensor does not communicate a timestamp and the PHG provides timestamps on its behalf.

**Case 1: PHG translates sensor timestamps**

The presence of a coincident timestamp with the presence of time capabilities OBX indicates that the PHG has translated the original sensor timestamps to the UTC or local timeline. The coincident timestamp pair with the sensor timestamp in OBX-5 and the corresponding $DTM_{PHG}$ in OBX-14 allows the PHG to report sensor observations on the UTC timeline and documents the sensor to

$DTM_{PHG}$ conversions for auditing purposes. This information may be used by the Services receiver to reconstruct the original sensor time, assuming that discontinuities do not exist in the original sensor timeline.

The MDC_TIME_RES_REL and MDC_TIME_RES_REL_HI_RES MDS-OBX segments specify the resolution of the sensor's relative and hi-res relative clocks, respectively. If these values are not reported (indicates unknown), the default resolution of 125 μs and 1 μs shall be assumed.

**Case 2: PHG does not translate device timestamps**

The absence of a coincident timestamp with the presence of time capabilities OBX indicates the original absolute (ABS) sensor time is reported in OBX-14 as an 'unqualified local time' (without a time zone offset) or the original base-offset (BO) sensor time is reported in OBX-14 having a ±ZZZZ or −0000 time zone offset.

This option allows the PHG to report the original sensor timestamps in cases where (1) the sensor's qualified base-offset timestamps are presumed to be more accurate than the PHG's or (2) when the PHG is not synchronized to an external time reference and therefore cannot translate reliability.

**Case 3: PHG provides timestamp on behalf of device**

The lack of a coincident timestamp and time capabilities OBX indicates that the device is not capable of providing timestamps and that the OBX-14 timestamps in subsequent OBXs are provided by the PHG on behalf of the device.

### D.1.5.3 PHG and sensor timestamps

Table D.16 shows how sensor timestamps may (or may not) be converted to the UTC timeline, given the (1) PHG clock capability, (2) the type of sensor timestamp and (3) whether a coincident timestamp pair is (or was) associated with the sensor observation. The symbol 'T(*)' indicates that the sensor time '*' can be translated to the UTC timeline, and assumes that the coincident timestamp pair exists and is disclosed using the MDC_ATTR_TIME_ { ABS, BO, REL and REL_HI_RES } attribute(s). The symbol '*' indicates the original sensor time may be reported. Additional information such as PHG and sensor synchronization state and accuracy can be used if a choice between T(*) and * is permitted.

**Table D.16 – PHG and sensor timestamps**

| Case | PHG clock and timestamps | | | | Device timestamps | | |
|---|---|---|---|---|---|---|---|
| | NTP | Local | DST | TZ | Hi-res/Relative | Absolute (no TZ) | Base-Offset (±TZ) |
| A | Yes | Yes | Yes | ±ZZZZ | T(*)±ZZZZ | T(*)±ZZZZ else * | *±ZZZZ or T(*)±ZZZZ |
| B | Yes | Yes | No | ±ZZZZ | T(*)±ZZZZ | T(*)±ZZZZ else * | *±ZZZZ or T(*)±ZZZZ |
| C | Yes | No | No | −0000 | T(*)−0000 | T(*)−0000 else * | *±ZZZZ or T(*)−0000 |
| D | No | Yes | No | ±ZZZZ | T(*)±ZZZZ | T(*)±ZZZZ else * | *±ZZZZ or T(*)±ZZZZ |
| E | No | No | No | none | T(*) | * | *±ZZZZ |

**Table D.17 – PHG time behaviours**

| Case | PHG time description | Qualified | Error |
|---|---|---|---|
| A | Best: Displayed time and time zone known (by DST rules) | Yes | < 1 s |
| B | Better: Displayed time and time zone known (by external information) | Yes | < 1 s |
| C | Good: UTC time known but displayed time and zone unknown | Yes | < 1 s |
| D | Usable: Qualified time but not synchronized (e.g., manually set by user) | Yes | < 120 s |
| E | Poor: Unqualified and unsynchronized local time (UTC and TZ unknown) | No | ≈ 1 hour |

A PHG operating in mode A shall correctly translate all timestamps including all stored observations that straddle a change of DST.

A PHG operating in mode B shall correctly translate most timestamps but will be unable to correctly translate stored observations that straddle a change of DST.

A PHG operating in mode C shall correctly translate timestamps to UTC but will be unable to correctly translate to local time.

A PHG operating in mode D shall translate timestamps but accuracy is unknown.

A PHG operating in mode E shall not translate timestamps.

**Column definitions for PHG clock and timestamp properties:**

**Case** is a label for each combination of **PHG Clock** and **Timestamp** properties, including:

**NTP**: 'Yes' if synchronized to global time reference such as NTP, CDMA, GSM NITZ, … , 'No' if not.

**Local**: 'Yes' if current local time zone offset is known, 'No' if not.

**DST**: 'Yes' if aware of local Daylight Savings Time rules, 'No' if not.

NOTE – An PHG that supports daylight savings rules is capable of providing the correct offsets to measurements received from a sensor before the daylight savings time change. The timeline is reported in the time zone of the PHG. It is assumed that the date-time-adjustment provided by the sensor is only due to daylight savings changes; no combinations of clock skew or time zone changes are part of the date-time-adjustment value.

**TZ**: ±ZZZZ if civil time zone offset known, −0000 if only UTC time is known, 'none' if unknown.

**Qualified**: 'Yes' if "qualified" by having a ±ZZZZ or −0000 time zone offset.

**Error**: Nominal error (e.g., "unqualified local time will be incorrect for 23 out of 24 time zones")

**Column definitions for sensor timestamps:**

1. **T(*)** refers to **translated sensor timestamps**, indicated by presence of a coincident timestamp.

2. ***** indicates an **original sensor timestamp**, indicated by the absence of a coincident timestamp but with time capabilities.

3. **±ZZZZ** indicates time-zone offset, **−0000** indicates UTC / NTP time, no suffix after T(*) or * indicates "local" time.

4. XXX **else** YYY indicates XXX preferred over YYY; XXX **or** YYY indicates no preference.

NOTE 1 – For TZ = −0000, the services receiver could adjust time zone based on 'local agreement' without loss of accuracy.

NOTE 2 – If PHG is used in a known or restricted geographic area, services receiver could adjust time zone based on 'local agreement'.

**General comments (informative)**

For the **Hi-res/Relative** sensor timestamp column, translation T(*) is required to convert the integer count to the PHG UTC timeline.

For the **Absolute** sensor timestamp column, translation T(*) is required to convert the absolute time to the PHG UTC timeline as well as local time with timezone offset. The transformation can only be performed if a coincident timestamp pair is captured and does not have any discontinuities due to Daylight Savings or other adjustments during the time interval [OBR-7, OBR-8) since T(*) is a linear transformation. If this condition cannot be guaranteed it is recommended that the original unqualified local timestamp '*' be sent instead.

For the **Base-Offset** sensor timestamp column, the original *±ZZZZ or translated T(*)±ZZZZ timestamp may be sent, with a preference for the former unless it was necessary for the PHG to correct for sensor clock drift.

For an **PHG clock that is unsynchronized and is unaware of local time** (row/Case E), an **absolute** sensor time shall be sent as an unqualified '*' timestamp, a **base-offset** sensor time shall be sent as a qualified or unqualified *±ZZZZ timestamp, depending upon the base-offset time base alignment, with no correction applied, and a **hi-res/relative** time shall be translated and sent as an unqualified T(*) timestamp.

**Additional PHG and sensor timestamp selection rules**

The previous table indicates a choice between using the PHG translated time T(*) and the original device time * for certain combinations of PHG and device timestamps. This section provides further guidance regarding the selection, based on the whether the PHG and/or device time is synchronized, and in the case where both are synchronized, their relative synchronization accuracy (if known).

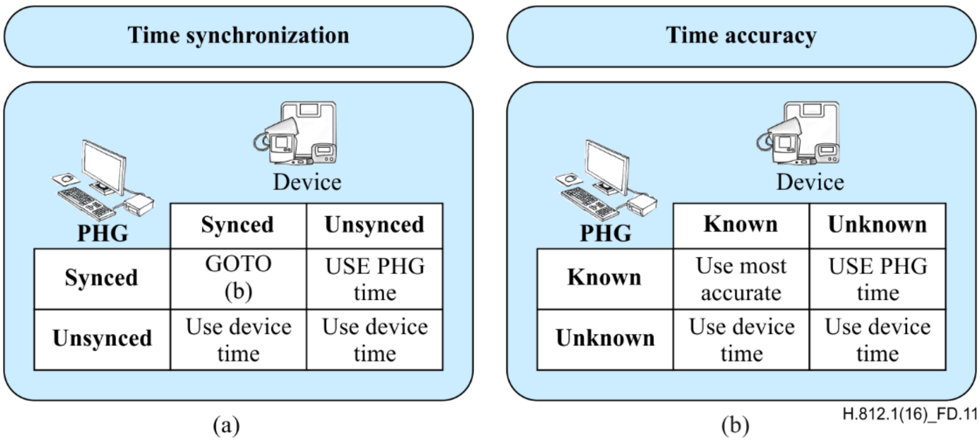


**Figure D-1 – PHG and sensor time accuracy selection**

### D.1.5.4 HL7 timebase identifier

In Table D.18 this Recommendation defines the following HL7 user table for OBX-18-2: Namespace ID.

**Table D.18 – HL7 user table for OBX-18-2**

| OBX-18-2 | Description | Examples |
|---|---|---|
| TIMEBASE_ID | A universally unique identifier of the timebase used for a given relative timestamp | 732d2650-2cd1-11df-8a39-0800200c9a66^TIMEBASE_ID<br>BT_HDP-ABCDEF123456-1^TIMEBASE_ID (see Note) |
| NOTE – One suggested approach for defining this unique identifier is to use the 3-tuple of the synchronization protocol, an identifier for the synchronization source (e.g., a bluetooth address), and the 'epoch' of this clock (e.g., an integer value which increments with each new association, or a datetime signifying the start of the last synchronization). | | |

Two relative or high-resolution relative observations are 'comparable' if and only if the OBX-18 values match exactly. Note that this information for sensor devices cannot be obtained using any of the Continua protocols and thus inclusion of an OBX-18 field in the OBX segments describing the sensor relative timestamps is optional.

### D.1.5.5 Synchronization protocols

Beyond the use of the MDC_ATTR_TIME_ABS, MDC_ATTR_TIME_BO, MDC_ATTR_TIME_REL and MDC_ATTR_TIME_REL_HI_RES time code observations, a services observation sender provides additional information about the personal health device clocks by communicating the MDC_TIME_SYNC_PROTOCOL of a given sensor (the sensor device is required to send this information if it supports any type of real time clock). Valid synchronization profiles are shown in Table D.19.

**Table D.19 – Time synchronization nomenclature codes**

| OBX-5 | Synchronization protocol | Part::Code |
|---|---|---|
| 532224^MDC_TIME_SYNC_NONE^MDC | An uncalibrated and unsynchronized local clock source<br>NOTE – If MDC_TIME_SYNC_ACCURACY is unknown or exceeds five minutes, MDC_TIME_SYNC_PROTOCOL shall be set to MDC_TIME_SYNC_NONE to indicate an uncalibrated and unsynchronized local clock. | 8::7936 |
| 532234^MDC_TIME_SYNC_EBWW^MDC | A manually set time, by 'eyeball and wristwatch' | 8::7946 |
| 532225^MDC_TIME_SYNC_NTPV3^MDC | Network Time Protocol Version 3.0 (RFC 1305) | 8::7937 |
| 532226^MDC_TIME_SYNC_NTPV4^MDC | Network Time Protocol Version 4.0 (under dev) | 8::7938 |
| 532227^MDC_TIME_SYNC_SNTPV4^MDC | Simple Network Time Protocol v4 (RFC 2030) | 8::7939 |
| 532228^MDC_TIME_SYNC_SNTPV4330^MDC | Simple Network Time Protocol v4 (RFC 4330) | 8::7940 |
| 532229^MDC_TIME_SYNC_BTV1^MDC | Bluetooth Medical Device Profile | 8::7941 |
| 532235^MDC_TIME_SYNC_USB_SOF^MDC | Synced to the 1kHz USB "start-of-frame" clock | 8::7947 |

**Table D.19 – Time synchronization nomenclature codes**

| OBX-5 | Synchronization protocol | Part::Code |
|---|---|---|
| 532230^MDC_TIME_SYNC_RADIO^MDC | Atomic Clock synchronization through RF | 8::7942 |
| 532231^MDC_TIME_SYNC_HL7_NCK^MDC | Synchronized via Health Level 7 NCK (network clock) | 8::7943 |
| 532232^MDC_TIME_SYNC_CDMA^MDC | CDMA mobile telecommunications synchronization | 8::7944 |
| 532233^MDC_TIME_SYNC_GSM^MDC | GSM - Network Identity and Time Zone (NITZ) | 8::7945 |

### D.1.5.6 Absolute or base offset timestamp accuracy

Absolute or base-offset timestamp 'accuracy' **may** be reported using MDC_TIME_SYNC_ACCURACY. For instance, if the sensor's clock has been synchronized using the Internet 'Network Time Protocol' [RFC 1305], 'Simple Network Time Protocol' [RFC 2030], the HL7 v2.6 'NCK' system clock segment, or another sufficiently capable time synchronization protocol, it is possible to compute the possible drift in accuracy since the device's last synchronization.

NOTE – NTP timestamp accuracy can be estimated from the NTP variables: root dispersion + ½ root delay + the cumulative clock drift (typically 20 ppm times the elapsed time since the agent had last synchronized to NTP). For other absolute time distribution protocols (e.g., mobile phone) other methods might be used (and are currently beyond the scope of this document).

Estimated values for accuracy may be reported in cases where the agent had acquired and stored data while disconnected from a time synchronization source. However, the PHG can only obtain this information if the sensor populates the respective ASN.1 structures in the Mds-Time-Info attribute. [ISO/IEEE 11073-20601] allows the sensor to populate the time synchronization accuracy field with unknown regardless of its synchronization state.

If MDC_TIME_SYNC_ACCURACY is unknown or exceeds five minutes, MDC_TIME_SYNC_PROTOCOL shall be set to MDC_TIME_SYNC_NONE to indicate an uncalibrated and unsynchronized local clock. Note that this value overrides what the sensor reports in the Mds-Time-Info synchronization protocol field.

MDC_TIME_SYNC_ACCURACY **shall not** be reported for the PHG if the PHG clock has not been synchronized, as sensors that use PHGs as a time synchronization service may rely on this value to determine whether they should update their own clocks and to qualify the accuracy of their own timestamps. Note that [ISO/IEEE 11073-20601] sensors cannot obtain any knowledge about the PHG's time capabilities or synchronization state via the 11073-20601 or any Continua defined protocol; this information would require the use of a non-Continua protocol or be obtained out of band. The PHG's timestamp accuracy does not include the communication latency between the PHG and the timeserver; it only specifies the known accuracy of the PHG's timestamp relative to a primary reference clock source.[2] The example below is a case where the PHG has determined that it

[2] At the time of this writing, [IEEE 11073-20601] does not specify a high-resolution time synchronization protocol, such as the 'IEEE:1073:3:2:SNTP' IAS service defined in the informative Annex N of [ISO/IEEE 11073-30200-2004]. The latter supports the exchange of 48-octet NTP or SNTP messages between a client (DCC) and server (BCC) using the 'expedited' TTP_UData transport service (similarly, NTP and SNTP use a 'best effort' UDP/IP transport over UDP port 123).

has superior synchronization capabilities to the sensor as indicated by the presence of the coincident timestamp pair in the MDS-OBXes.

```
OBX|n|DTM|67975^MDC_ATTR_TIME_ABS^MDC|1.0.0.x|20091028123702||||||R|||20091028173702+0000
OBX|n+1|CWE|68219^MDC_TIME_CAP_STATE^MDC|1.0.0.x+1|(other set bits)~1^mds-time-capab-sync-abs-time(4)~1^mds-time-state-abs-time-synced(8)|||||R
OBX|n+2|CWE|68220^MDC_TIME_SYNC_PROTOCOL^MDC|1.0.0.x+2|532228^MDC_TIME_SYNC_SNTPV4330^MDC|||||R
OBX|n+3|NM|68221^MDC_TIME_SYNC_ACCURACY^MDC|1.0.0.x+3|1200000|264339^MDC_DIM_MICRO_SEC^MDC|||||R
```

### D.1.5.7 Time synchronization examples

#### D.1.5.7.1 Devices using absolute time

This example sends a blood pressure observation (systolic, diastolic and mean arterial pressure) for a patient in Los Angeles taken at 09:10:05 on 8 January 2010 from a personal health device which had an internal time of 14:03:45 1 January 1900 at 14:03:45 on 4 Jan 2010. In practice, for this situation to occur it requires that the sensor associate with the PHG at 14:03:45 on 4 January 2010 and remain associated with the PHG for four days before the measurement is taken at 09:10:05 on 8 January 2010. In addition, the sensor's clock is clearly uninitialized. The resulting PCD-01 message (with several required OBX elements not present for simplicity) is as follows:

```
MSH|^~\&|AcmeInc^ACDE48234567ABCD^EUI-64||||20100108091005-
0800||ORU^R01^ORU_R01|MSGID1234|P|2.6|||NE|AL|||||IHE PCD ORU-R01
2006^HL7^2.16.840.1.113883.9.n.m^HL7
PID|||789567^^^Imaginary Hospital^PI ||Doe^John^Joseph^^^^L^A|||M
OBR|1|AB12345^AcmePHGInc^ACDE48234567ABCD^EUI-64|AB12345^AcmePHGInc^ACDE48234567ABCD^EUI-
64|182777000^monitoring of patient^SNOMED-CT|||20100108091005-0800
Top level PHG OBX
OBX|2|CWE|68220^MDC_TIME_SYNC_PROTOCOL^MDC|0.0.0.1|532224^MDC_TIME_SYNC_NONE^MDC|||||R
More PHG OBXes
OBX|n||528391^MDC_DEV_SPEC_PROFILE_BP^MDC|1|||||||X|||||||0123456789ABCDEF^^0123456789ABCDEF^EUI-
64
More MDS OBXes
OBX|n+1|DTM|67975^MDC_ATTR_TIME_ABS^MDC|1.0.0.x|19000101140345||||||R|||20100104140345-0800
OBX|n+2||150020^MDC_PRESS_BLD_NONINV^MDC|1.0.1|||||||X|||20100108091005-0800
OBX|n+3|NM|150021^MDC_PRESS_BLD_NONINV_SYS^MDC|1.0.1.1|120|266016^MDC_DIM_MMHG^MDC|||||R
OBX|n+4|NM|150022^MDC_PRESS_BLD_NONINV_DIA^MDC|1.0.1.2|80|266016^MDC_DIM_MMHG^MDC|||||R
OBX|n+5|NM|150023^MDC_PRESS_BLD_NONINV_MEAN^MDC|1.0.1.3|100|266016^MDC_DIM_MMHG^MDC|||||R
```

At the time of association the sensor's time is 14:03:45 1 January 1900. The actual time is 14:03:45 on 4 January 2010. The PHG notes that the sensor is using absolute time so it assumes that it is the local time of the current time zone where the PHG itself is located and that is Los Angeles. The PHG then computes the difference. Ideally that difference is zero. But in this case the sensor is 40,179 days, 19 hours, 55 minutes and 19 seconds behind. When the sensor takes a measurement some four days later (still associated with the PHG) where it is assumed the sensor's clock advances correctly, the PHG adds the 40,179 days, 19 hours, 55 minutes and 19 seconds to the sensor's newly reported time in the scan event report. This time is then expressed as a DTM timestamp 2010104140345-0800 where UTC is obtained by subtracting the offset – (−8 hours) to the field time 2010104140345 (effectively adding 8). Note that the timestamp is correct since the sensor's error has been compensated for.

#### D.1.5.7.2 Sensors using a Bluetooth clock

The example below shows a PHG that synchronized to an NTP V3 (IETF RFC 1305) time reference using a LAN or Services connection. The PHG also provides a synchronization clock for Bluetooth sensors using its Bluetooth clock and is represented as 64-bit high-resolution relative timestamps with a resolution of 1 µsec. The PHG is also aware that the sensor is using this service to generate its [ISO/IEEE 11073-20601] relative timestamps*. Since the PHG generates the underlying Bluetooth clock, it can correlate the high-resolution relative timestamps with an absolute timestamp if NTP or other reference time is available. The OBXs related to PHG timekeeping are shown below:

```
Top level PHG OBX
OBX|n|CWE|68220^MDC_TIME_SYNC_PROTOCOL^MDC|0.0.0.x|532225^MDC_TIME_SYNC_NTPV3^MDC|||||R
OBX|n+1|NM|68221^MDC_TIME_SYNC_ACCURACY^MDC|0.0.0.x+1|0.18|264320^MDC_DIM_SEC^MDC|||||R
OBX|n+2|NM|67984^MDC_ATTR_TIME_STAMP_HI_RES^MDC|0.0.0.x+2|43567138204032|264339^MDC_DIM_MICRO_SEC^MD
C|||||R|||20091028123702.1362+0000||||ABCDEF123456^TIMEBASE_ID
OBX|n+3|NM|68224^MDC_ATTR_TIME_REL^MDC|0.0.0.x+3|1.0|264339^MDC_DIM_MICRO_SEC^MDC|||||R|||||||BT_ABC
DEF123456_01^TIMEBASE_ID
More PHG OBXes
```

The sensor indicates that it uses Bluetooth timestamps, with a time synchronization accuracy of 10 µs, relative to the Bluetooth HDP hi-res timestamps, as shown below:

NOTE – The sensor cannot indicate to the PHG that is uses Bluetooth timestamps using Continua defined personal health device protocols. The information for OBX-18 must be obtained out of band.

```
OBX|m||528388^MDC_DEV_SPEC_PROFILE_PULS_OXIM^MDC|1|||||||X|...
OBX|m+1|CWE|68219^MDC_TIME_CAP_STATE^MDC|1.0.0.2||1^mds-time-capab-sync-hi-res-relative-time(6)~1^
mds-time-state-hi-res-relative-time-synced(10)|||||R
OBX|m+2|CWE|68220^MDC_TIME_SYNC_PROTOCOL^MDC|1.0.0.3||532229^MDC_TIME_SYNC_BTV1^MDC|||||R
OBX|m+3|NM|68221^MDC_TIME_SYNC_ACCURACY^MDC|1.0.0.4|10|264339^MDC_DIM_MICRO_SEC^MDC|||||R
More MDS OBXes
OBX|k|NM|150456^MDC_PULS_OXIM_SAT_O2^MDC|1.0.0.x|98|262688^MDC_DIM_PERCENT^MDC|||||R
OBX|k+1|NM|67984^MDC_ATTR_TIME_STAMP_HI_RES^MDC|1.0.0.x.1|132434|264339^MDC_DIM_MICRO_SEC^MDC|||||R|
||||||BT_ABCDEF123456_01^TIMEBASE_ID
OBX|k+2|NM|150456^MDC_PULS_OXIM_SAT_O2^MDC|1.0.0.x+1|98.1|262688^MDC_DIM_PERCENT^MDC|||||R
OBX|k+3|NM|67984^MDC_ATTR_TIME_STAMP_HI_RES^MDC|1.0.0.x+1.1|232802|264339^MDC_DIM_MICRO_SEC^MDC|||||
R|||||||BT_ABCDEF123456_01^TIMEBASE_ID
```

### D.1.6 Metric object attribute mappings overview

The common metric attributes used to code the Metric OBX segments are shown in Table D.20. Attributes not included in the table are not encoded into OBX segments.

**Table D.20 – Generic metric attributes**

| Attribute | Ref Id | Encoding Instructions |
|---|---|---|
| Type | MDC_ATTR_ID_TYPE | OBX-3:clause D.1.3.1.1 |
| Supplemental-Types | MDC_ATTR_SUPPLEMENTAL_TYPES | Facet:clause D.1.3.1.6.2 |
| Measurement-Status | MDC_ATTR_MSMT_STAT | OBX-8:clauses D.1.3.1.4 and D.3.3.1 |
| Metric-Id | MDC_ATTR_ID_PHYSIO | OBX-3:clause D.1.3.1.6 |
| Metric-Id- List | MDC_ATTR_ID_PHYSIO_LIST | OBX-3:clause D.1.3.2.2 |
| Metric-Id-Partition | MDC_ATTR_METRIC_ID_PART | Used by Metric-Id and Metric-Id-List. |
| Unit-Code | MDC_ATTR_UNIT_CODE | OBX-6:clause D.1.3.1.2 |
| Source-Handle-Reference | MDC_ATTR_SOURCE_HANDLE_REF | Facet:clause D.1.3.1.6.1 |
| Label-String | MDC_ATTR_ID_LABEL_STRING | OBX-3:clause D.1.3.1.1 |
| Unit-LabelString | MDC_ATTR_UNIT_LABEL_STRING | OBX-6:clause D.1.3.1.2 |
| Absolute-Time-Stamp | MDC_ATTR_TIME_STAMP_ABS | OBX-14:clause D.1.3.1.5 |
| Base-Offset-Time-Stamp | MDC_ATTR_TIME_STAMP_BO | OBX-14:clause D.1.3.1.5 |
| Relative-Time-Stamp | MDC_ATTR_TIME_STAMP_REL | Facet:clause D.1.3.1.6.6 |
| HiRes-Time-Stamp | MDC_ATTR_TIME_STAMP_HI_RES | Facet:clause D.1.3.1.6.7 |
| Measure-Active-Period | MDC_ATTR_TIME_PD_MSMT_ACTIVE | Facet:clause D.1.3.1.6.4 |

### D.1.7 Numeric (subclass of Metric)

Attributes not shown in the table **are not** encoded into OBX segments.

**Table D.21 – Numeric (subclass of metric)**

| Attribute | Ref Id | Encoding instructions |
|---|---|---|
| Simple-Nu-Observed-Value | MDC_ATTR_NU_VAL_OBS_SIMP | Clause D.1.3.1.3.1 |
| Compound-Simple-Nu-Observed-Value | MDC_ATTR_NU_CMPD_VAL_OBS_SIMP | Clause D.1.3.2.2 |
| Basic-Nu-Observed-Value | MDC_ATTR_NU_VAL_OBS_BASIC | Clause D.1.3.1.3.1 |
| Compound-Basic-Nu-Observed-Value | MDC_ATTR_NU_CMPD_VAL_OBS_BASIC | Clause D.1.3.2.2 |
| Nu-Observed-Value | MDC_ATTR_NU_VAL_OBS | Clause D.1.3.1.3.1 |
| Compound-Nu-Observed-Value | MDC_ATTR_NU_CMPD_VAL_OBS | Clause D.1.3.2.3 |
| Accuracy | MDC_ATTR_NU_ACCUR_MSMT | Facet: clause D.1.3.1.6.5 |

### D.1.8 RT-SA (subclass of Metric)

Attributes not shown in the table **are not** encoded into OBX segments.

**Table D.22 – RT-SA (subclass of metric)**

| Attribute | Ref Id | Encoding instructions |
|---|---|---|
| Sample-Period | MDC_ATTR_TIME_PD_SAMP | Facet:clause D.1.3.1.6.8 |
| Simple-Sa-Observed-Value | MDC_ATTR_SIMP_SA_OBS_VAL | Clause D.1.3.1.6.8 |
| Sa-Specification | MDC_ATTR_SA_SPECN | Facet:clause D.1.3.1.6.9 |

### D.1.9 Enumeration (subclass of Metric)

Attributes not shown in the table **are not** encoded into OBX segments.

**Table D.23 – Enumeration (subclass of metric)**

| Attribute | Ref Id | Encoding instructions |
|---|---|---|
| Enum-Observed-Value-Simple-OID | MDC_ATTR_ENUM_OBS_VAL_SIMP_OID | Clause D.1.3.1.3.2.2 |
| Enum-Observed-Value-Simple-Bit-Str | MDC_ATTR_ENUM_OBS_VAL_SIMP_BIT_STR | Clause D.1.3.1.3.2.1 |
| Enum-Observed-Value-Basic-Bit-Str | MDC_ATTR_ENUM_OBS_VAL_BASIC_BIT_STR | Clause D.1.3.1.3.2.1 |
| Enum-Observed-Value-Simple-Str | MDC_ATTR_ENUM_OBS_VAL_SIMP_STR | Clause D.1.3.1.3.2.3 |
| Enum-Observed-Value | MDC_ATTR_VAL_ENUM_OBS | Clause D.1.3.1.3.2.4 |

# Annex E

## Mapping from the IEEE 11073-104xx device specializations to the Continua services

(This annex forms an integral part of this Recommendation.)

The following clause gives guidance as to the recommended encoding of the OBX segments. This clause contains the specific guidance for the correct mapping of all devices. Additionally, it gives the hierarchy for the MDS object. The guidance for each device is composed of four elements:

1. **Modelling.** This gives a brief description of the main modelling decisions.
2. **Transformations.** This gives a list of all transformations to be done for the specific device.
3. **Containment tree.** This shows the relationship of the individual observations to each other and the device. The hierarchical relationship is denoted by the "…" used in the REFID column. The number of dots indicate the place of that observation in the hierarchy.
4. **OBX encoding**
   a) OBX encoding Part 1. This table shows the data type of the value, observation identifier, observation sub-type (hierarchy) and observation value. Note the actual entries in OBX-4 are not to be taken at face value since they will depend upon OBX segments that may come before those noted in table.
   b) OBX encoding Part 2. This table shows the observation units, equipment instance identifier and observation site.

Examples of the primary observations and their encoding are given in the following subclauses.

Table E.1 shows Continua-defined MDC codes that are not part of [ISO/IEEE 11073-20601] personal health devices data exchanges.

**Table E.1 – Continua-defined MDC codes that are not part of ISO/IEEE 11073-20601 personal health devices data exchanges**

| Partition | Nomenclature code's common name | Code |
|---|---|---|
| MDC_PART_OBJ | MDC_REG_CERT_DATA_AUTH_BODY | 2682 |
| MDC_PART_INFRA | MDC_MOC_VMS_MDS_PHG | 7693 |
| MDC_PART_INFRA | MDC_REG_CERT_DATA_CONTINUA_VERSION | 8064 |
| MDC_PART_INFRA | MDC_REG_CERT_DATA_CONTINUA_CERT_DEV_LIST | 8065 |
| MDC_PART_INFRA | MDC_REG_CERT_DATA_CONTINUA_REG_STATUS | 8066 |
| MDC_PART_INFRA | MDC_REG_CERT_DATA_CONTINUA_PHG_CERT_LIST | 8067 |

It should be noted that:

The hierarchical notation shown in the OBX-4 column is example only. Particularly for the metric level and lower, they are illustrative only to show the notational level and specific numbers can vary from message to message, as long as the relationships are maintained.

Additionally, the values in columns OBX-5, OBX-18 and OBX-20 are only examples.

## E.1 PHG

### E.1.1 Modelling

The PHG-OBXes are modelled from a hypothetical MDS object on the PHG as described in clause D.1.1.

### E.1.2 Containment tree

Table E.2 shows a PHG containment tree.

**Table E.2 – PHG containment tree**

| REFID | Description |
|---|---|
| `... MDC_ATTR_TIME_REL` | Relative-Time |
| `... MDC_ATTR_TIME_REL_HI_RES` | HiRes-Relative-Time |
| `... MDC_TIME_SYNC_PROTOCOL` | Time-Sync-Protocol (hypothetical decomposition of MDC_ATTR_MDS_TIME_INFO) |
| `... MDC_TIME_SYNC_ACCURACY` | Time-Sync-Accuracy (hypothetical decomposition of MDC_ATTR_MDS_TIME_INFO) |
| `... MDC_TIME_RES_ABS` | Time-Resolution-Abs-Time (hypothetical decomposition of MDC_ATTR_MDS_TIME_INFO) |
| `... MDC_TIME_RES_REL` | Time-Resolution-Rel-Time (hypothetical decomposition of MDC_ATTR_MDS_TIME_INFO) |
| `... MDC_TIME_RES_REL_HI_RES` | Time-Resolution-High-Res-Time (hypothetical decomposition of MDC_ATTR_MDS_TIME_INFO) |
| `... MDC_REG_CERT_DATA_AUTH_BODY` | Regulation-Certification-Auth-Body (hypothetical decomposition of MDC_ ATTR_REG-CERT-DATA-LIST Authority Body sub element) |
| `.... MDC_REG_CERT_DATA_CONTINUA_VERSION` | Regulation-Certification-Continua-Version (hypothetical decomposition of MDC_ATTR_REG-CERT-DATA-LIST Continua Body Certified Device Version sub element) |
| `.... MDC_REG_CERT_DATA_CONTINUA_CERT_DEV_LIST` | Regulation-Certification-Continua-Certified-Device-List (hypothetical decomposition of MDC_ ATTR_REG-CERT-DATA-LIST Continua Body Certified Device List sub element) |
| `... MDC_REG_CERT_DATA_AUTH_BODY` | Regulation-Certification-Auth-Body (hypothetical decomposition of MDC_ ATTR_REG-CERT-DATA-LIST Authority Body sub element) |

**Table E.2 – PHG containment tree**

| REFID | Description |
|---|---|
| .... MDC_REG_CERT_DATA_CONTINUA_REG_STATUS | Regulation-Certification-Continua-Regulation-Status (hypothetical decomposition of MDC_ ATTR_REG-CERT-DATA-LIST Continua Body Regulation Status sub element) |
| ... MDC_REG_CERT_DATA_AUTH_BODY | Regulation-Certification-Auth-Body (hypothetical decomposition of MDC_ ATTR_REG-CERT-DATA-LIST Authority Body sub element) |
| .... MDC_REG_CERT_DATA_CONTINUA PHG_CERT_LIST | Regulation-Certification-Continua-PHG-Cert-List |

## E.2 MDS object

### E.2.1 Modelling

All attributes are metrics of the MDS object.

### E.2.2 Containment tree

Table E.3 shows an MDS containment tree.

**Table E.3 – MDS containment tree**

| REFID | Description |
|---|---|
| MDC_DEV_SPEC_PROFILE_* | Specific device MDS |
| ... MDC_ATTR_SYS_TYPE | System-Type |
| ... MDC_ATTR_ID_FIELD_MODEL_NUMBER | System-Model (decomposition of MDC_ATTR_ID_MODEL attribute) |
| ... MDC_ATTR_ID_FIELD_MODEL_MANUFACTURER | System-Manufacturer (decomposition of MDC_ATTR_ID_MODEL attribute) |
| ... MDC_ATTR_SYS_ID | System-Id |
| ... MDC_ID_PROD_SPEC_UNSPECIFIED | Production-Specification-Unspecified (decomposition of MDC_ATTR_ID_PROD_SPECN) |
| ... MDC_ID_PROD_SPEC_SERIAL | Production-Specification-Serial (decomposition of MDC_ATTR_ID_PROD_SPECN) |
| ... MDC_ID_PROD_SPEC_PART | Production-Specification-Part (decomposition of MDC_ATTR_ID_PROD_SPECN) |
| ... MDC_ID_PROD_SPEC_HW | Production-Specification-Hardware (decomposition of MDC_ATTR_ID_PROD_SPECN) |
| ... MDC_ID_PROD_SPEC_SW | Production-Specification-Software (decomposition of MDC_ATTR_ID_PROD_SPECN) |

**Table E.3 – MDS containment tree**

| REFID | Description |
|---|---|
| ... MDC_ID_PROD_SPEC_FW | Production-Specification-Firmware (decomposition of MDC_ATTR_ID_PROD_SPECN) |
| ... MDC_ID_PROD_SPEC_PROTOCOL | Production-Specification-Protocol (decomposition of MDC_ATTR_ID_PROD_SPECN) |
| ... MDC_ID_PROD_SPEC_GMDN | Production-Specification-GMDN (decomposition of MDC_ATTR_ID_PROD_SPECN) |
| ... MDC_ATTR_TIME_ABS | Date-and-Time |
| ... MDC_ATTR_TIME_REL | Relative-Time |
| ... MDC_ATTR_TIME_REL_HI_RES | HiRes-Relative-Time |
| ... MDC_TIME_CAP_STATE | Mds-Time-Cap-State (decomposition of MDC_ATTR_MDS_TIME_INFO) |
| ... MDC_TIME_SYNC_PROTOCOL | Time-Sync-Protocol (decomposition of MDC_ATTR_MDS_TIME_INFO) |
| ... MDC_TIME_SYNC_ACCURACY | Time-Sync-Accuracy (decomposition of MDC_ATTR_MDS_TIME_INFO) |
| ... MDC_TIME_RES_ABS | Time-Resolution-Abs-Time (decomposition of MDC_ATTR_MDS_TIME_INFO) |
| ... MDC_TIME_RES_REL | Time-Resolution-Rel-Time (decomposition of MDC_ATTR_MDS_TIME_INFO) |
| ... MDC_TIME_RES_REL_HI_RES | Time-Resolution-High-Res-Time (decomposition of MDC_ATTR_MDS_TIME_INFO) |
| ... MDC_ATTR_POWER_STAT | Power-Status |
| ... MDC_ATTR_VAL_BATT_CHARGE | Battery-Level |
| ... MDC_ATTR_TIME_BATT_REMAIN | Remaining-Battery-Time |
| ... MDC_REG_CERT_DATA_AUTH_BODY | Regulation-Certification-Auth-Body (decomposition of MDC_ ATTR_REG-CERT-DATA-LIST Authority Body sub element) |
| .... MDC_REG_CERT_DATA_CONTINUA_VERSION | Regulation-Certification-Continua-Version (decomposition of MDC_ ATTR_REG-CERT-DATA-LIST Continua Body Certified Device Version sub element) |

**Table E.3 – MDS containment tree**

| REFID | Description |
|---|---|
| .... MDC_REG_CERT_DATA_CONTINUA_CERT_DEV_LIST | Regulation-Certification-Continua-Certified-Device-List (decomposition of MDC_ ATTR_REG-CERT-DATA-LIST Continua Body Certified Device List sub element) |
| ... MDC_REG_CERT_DATA_AUTH_BODY | Regulation-Certification-Auth-Body (decomposition of MDC_ ATTR_REG-CERT-DATA-LIST Authority Body sub element) |
| .... MDC_REG_CERT_DATA_CONTINUA_REG_STATUS | Regulation-Certification-Continua-Regulation-Status (decomposition of MDC_ ATTR_REG-CERT-DATA-LIST Continua Body Regulation Status sub element) |
| ... MDC_ATTR_SYS_TYPE_SPEC_LIST | System-Type-Spec-List |

### E.3 Metric OBXes

The following tables give the containment tree and detailed models of the Metric-OBXes for each of the specializations. Note that the absolute values of the OBX-4 containment values in the tables are illustrative only. Their purpose is to show instances and scope. OBX-8, OBX-11, OBX-14 and OBX-20 are also not shown in these tables. These entries depend upon the measurement status attribute or the occurrence of a special value (for example, NaN), the particular time scenario and the use of the supplemental types attribute. Their inclusion would add too much complexity to the tables.

#### E.3.1 10404 Pulse oximeter

##### E.3.1.1 Modelling

This is modelled with the measurements as individual METRIC level observations.

##### E.3.1.2 Transformations

The following transformations are performed in the encoding of this device.

##### E.3.1.3 Containment tree

Table E.4 shows a pulse oximeter containment tree.

**Table E.4 – Pulse oximeter containment tree**

| REFID | Description |
|---|---|
| MDC_DEV_SPEC_PROFILE_PULS_OXIM | Pulse oximeter MDS |
| ... MDC_PULS_OXIM_SAT_O2 | $SPO_2$ |
| .... MDC_ATTR_SUPPLEMENTAL_TYPES | $SPO_2$ Modality sent as a Supplemental-Type to the reading |
| .... MDC_ATTR_NU_ACCUR_MSMT | $SPO_2$ Accuracy |
| .... MDC_ATTR_AL_OP_STAT | $SPO_2$ Alert-Op-State |

**Table E.4 – Pulse oximeter containment tree**

| REFID | Description |
|---|---|
| .... MDC_ATTR_LIMIT_CURR | $SPO_2$ Current-Limits |
| .... MDC_ATTR_AL_OP_TEXT_STRING | $SPO_2$ Alert-Op-Text-String |
| ... MDC_ATTR_MSMT_STAT | $SPO_2$ Measurement-Status special cases |
| ... MDC_PULS_OXIM_PULS_RATE | Pulse rate |
| .... MDC_ATTR_SUPPLEMENTAL_TYPES | Pulse rate modality sent as a Supplemental-Type to the reading |
| .... MDC_ATTR_NU_ACCUR_MSMT | Pulse rate accuracy |
| ... MDC_PULS_OXIM_PERF_REL or<br>... MDC_SAT_O2_QUAL | Pulsatile quality |
| ... MDC_PULS_OXIM_PLETHM | Plethysmographic waveform |
| .... MDC_ATTR_TIME_PD_SAMP | Plethysmographic waveform sample period |
| ... MDC_TRIG | Pulsatile occurrence |
| .... MDC_ATTR_SOURCE_HANDLE_REF | Source-Handle-Reference<br>point to either the Pulsatile quality numeric object or the Plethysmogram RT-SA object. |
| ... MDC_PULS_OXIM_PULS_CHAR | Pulsatile characteristic |
| .... MDC_ATTR_SOURCE_HANDLE_REF | Source-Handle-Reference<br>point to either the Pulse amplitude numeric object or the Plethysmogram RT-SA object |
| ... MDC_PULS_OXIM_DEV_STATUS | Device and sensor annunciation Status |

### E.3.1.4 OBX encoding

Table E.5 and Table E.6 show part 1 and part 2 (respectively) of the pulse oximeter OBX encoding.

**Table E.5 – Pulse oximeter OBX encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| Pulse oximeter MDS | | 528388^MDC_DEV_SPEC_PROFILE_PULS_OXIM^MDC | 1 | |
| $SPO_2$ | NM | 150456^MDC_PULS_OXIM_SAT_O2^MDC | 1.0.0.1 | 93.4 |
| $SPO_2$ Modality | CWE | 68193^MDC_ATTR_SUPPLEMENTAL_TYPES^MDC | 1.0.0.1.1 | 150580^MDC_MODALITY_FAST^MDC or<br>150584^MDC_MODALITY_SLOW^MDC or<br>150588^MDC_MODALITY_SPOT^MDC |
| $SPO_2$ Accuracy | NM | 67914^MDC_ATTR_NU_ACCUR_MSMT^MDC | 1.0.0.1.2 | 2.3 |
| $SPO_2$ Alert-Op-State | CWE | 67846^MDC_ATTR_AL_OP_STAT^MDC | 1.0.0.1.3 | One of the values…<br><0 or 1>^lim-alert-off(0),<br><0 or 1>^lim-low-off(1), or<br><0 or 1>^lim-high-off(2) |
| $SPO_2$ Current-Limits | NM | 67892^MDC_ATTR_LIMIT_CURR^MDC | 1.0.0.1.4 | This is coded as a tuple of 2 numeric values with a "~" separating the values.<br><lower limit (NM)> ~ <upper limit (NM)><br>Example:<br>75.2~85.2 |
| $SPO_2$ Alert-Op-Text-String | ST | 68014^MDC_ATTR_AL_OP_TEXT_STRING^MDC | 1.0.0.1.5 | This is coded as a tuple of 2 string values with a "~" separating the values.<br><lower limit text (ST)> ~ <upper limit text (ST)><br>Example:<br>lower limit~upper limit |

## Table E.5 – Pulse oximeter OBX encoding – Part 1

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| SPO$_2$ Measurement-Status (Pulse Oximeter special settings) | CWE | 67911^MDC_ATTR_MSMT_STAT^MDC | 1.0.0.1.6 | One of the values…<br><0 or 1>^msmt-state-in-alarm(14),<br><0 or 1>^msmt-state-al-inhibited(15) |
| Pulse rate | NM | 149530^MDC_PULS_OXIM_PULS_RATE^MDC | 1.0.0.2 | 71 |
| Pulse rate modality | CWE | 68193^MDC_ATTR_SUPPLEMENTAL_TYPES^MDC | 1.0.0.2.1 | 150580^MDC_MODALITY_FAST^MDC or<br>150584^MDC_MODALITY_SLOW^MDC or<br>150588^MDC_MODALITY_SPOT^MDC |
| Pulse rate accuracy | NM | 67914^MDC_ATTR_NU_ACCUR_MSMT^MDC | 1.0.0.2.2 | 1.3 |
| Pulsatile quality | NM | 150448^MDC_PULS_OXIM_PERF_REL^MDC or<br>150320^MDC_SAT_O2_QUAL^MDC | 1.0.0.3 | 85.3 |
| Plethysmographic waveform | NA | 150452^MDC_PULS_OXIM_PLETH^MDC | 1.0.0.4 | 11^22^33^44^55^66^77^88^99^……<br>Note that the actual values of the waveform may need to be computed based on the scaling values in the Scale-And-Range-Specification object |
| Plethysmographic waveform sample period | NM | 67981^MDC_ATTR_TIME_PD_SAMP^MDC | 1.0.0.4.1 | 4000 |
| Pulsatile occurrence | CWE | 184322^MDC_TRIG^MDC | 1.0.0.5 | 184323^MDC_TRIG_BEAT^MDC or<br>184331^MDC_TRIG_BEAT_MAX_INRUSH^MDC or<br>192511^MDC_METRIC_NOS^MDC |
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_REF^MDC | 1.0.0.7.1 | 1.0.0.4 |
| Pulsatile characteristic | CWE | 150584^MDC_PULS_OXIM_PULS_CHAR^MDC | 1.0.0.6 | One of the values…<br><0 or 1>^pulse-qual-nominal(0),<br><0 or 1>^pulse-qual-marginal(1),<br><0 or 1>^pulse-qual-minimal(2),<br><0 or 1>^pulse-qual-unacceptable(3) |

**Table E.5 – Pulse oximeter OBX encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| Device and sensor annunciation status | CWE | 150604^MDC_PULS_OXIM_DEV_STATUS^MDC | 1.0.0.7 | One of the values…<br><0 or 1>^sensor-disconnected(0),<br><0 or 1>^sensor-malfunction(1),<br><0 or 1>^sensor-displaced(2),<br><0 or 1>^sensor-unsupported(3),<br><0 or 1>^sensor-off(4),<br><0 or 1>^sensor-interference(5),<br><0 or 1>^signal-searching(6),<br><0 or 1>^signal-pulse-questionable(7),<br><0 or 1>^signal-non-pulsatile(8),<br><0 or 1>^signal-erratic(9),<br><0 or 1>^signal-low-perfusion(10),<br><0 or 1>^signal-poor(11),<br><0 or 1>^signal-inadequate(12),<br><0 or 1>^signal-processing-irregularity(13),<br><0 or 1>^device-equipment-malfunction(14),<br><0 or 1>^device-extended-update(15) |

**Table E.6 – Pulse oximeter OBX encoding – Part 2**

| Description | OBX-6 | OBX-18 | OBX-20 |
|---|---|---|---|
| Pulse oximeter MDS | | 0123456789ABCDEF^^0123456789ABCDEF^EUI-64 | |
| $SPO_2$ | 262688^MDC_DIM_PERCENT^MDC | | |
| $SPO_2$ Modality | | | |
| $SPO_2$ Accuracy | 262688^MDC_DIM_PERCENT^MDC | | |
| $SPO_2$ Alert-Op-State | 262688^MDC_DIM_PERCENT^MDC | | |
| $SPO_2$ Current-Limits | 262688^MDC_DIM_PERCENT^MDC | | |
| $SPO_2$ Alert-Op-Text-String | | | |
| $SPO_2$ Measurement-Status | | | |
| Pulse rate | 264864^MDC_DIM_BEAT_PER_MIN^MDC | | |
| Pulse rate modality | | | |
| Pulse rate accuracy | 264864^MDC_DIM_BEAT_PER_MIN^MDC | | |
| Pulsatile quality | when OBX-2 is MDC_PULS_OXIM_PERF_REL then units are 262656^MDC_DIM_DIMLESS^MDC or when OBX-2 is MDC_SAT_O2_QUAL then units are 262688^MDC_DIM_PERCENT^MDC | | |
| Plethysmographic waveform | 262656^MDC_DIM_DIMLESS^MDC or 268738^MDC_DIM_MICRO_ABSORBANCE^MDC | | |
| Plethysmographic waveform sample period | 264339^MDC_DIM_MICRO_SEC^MDC | | |
| Pulsatile occurrence | | | |
| Source-Handle-Reference | | | |
| Pulsatile characteristic | | | |
| Source-Handle-Reference | | | |
| Device and sensor annunciation status | | | |

### E.3.2 10407 Blood pressure monitor

#### E.3.2.1 Modelling

There is one channel/group to hold all the metric level measurements. This specialization uses compound numeric attributes and the containment Metric-OBX is placed on the channel n-tuple.

#### E.3.2.2 Transformations

The following transformations are performed in the encoding of this device.

#### E.3.2.3 Containment tree

Table E.7 shows a blood pressure monitor containment tree.

**Table E.7 – Blood pressure monitor containment tree**

| REFID | Description |
|---|---|
| `MDC_DEV_SPEC_PROFILE_BP` | Blood pressure MDS |
| `.. MDC_PRESS_BLD_NONINV` | Systolic/Diastolic/MAP |
| `... MDC_PRESS_BLD_NONINV_SYS` | Systolic |
| `... MDC_PRESS_BLD_NONINV_DIA` | Diastolic |
| `... MDC_PRESS_BLD_NONINV_MEAN` | Mean arterial pressure |
| `... MDC_PULS_RATE_NON_INV` | Pulse rate |

### E.3.2.5 OBX encoding

Table E.8 and Table E.9 show part 1 and part 2 (respectively) of a blood pressure monitor encoding.

**Table E.8 – Blood pressure monitor encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| Blood pressure MDS | | 528391^MDC_DEV_SPEC_PROFILE_BP^MDC | 1 | |
| Systolic/Diastolic/MAP | | 150020^MDC_PRESS_BLD_NONINV^MDC | 1.0.1 | |
| Systolic | NM | 150021^MDC_PRESS_BLD_NONINV_SYS^MDC | 1.0.1.1 | 123.0 |
| Diastolic | NM | 150022^MDC_PRESS_BLD_NONINV_DIA^MDC | 1.0.1.2 | 85.0 |
| Mean arterial pressure | NM | 150023^MDC_PRESS_BLD_NONINV_MEAN^MDC | 1.0.1.3 | 103.0 |
| Pulse rate | NM | 149546^MDC_PULS_RATE_NON_INV^MDC | 1.0.0.1 | 73 |

**Table E.9 – Blood pressure monitor encoding – Part 2**

| Description | OBX-6 | OBX-18 | OBX-20 |
|---|---|---|---|
| Blood pressure MDS | | 0123456789ABCDEF^^0123456789ABCDEF^EUI-64 | |
| Systolic/Diastolic/MAP | | | |
| Systolic | 266016^MDC_DIM_MMHG^MDC or 265987^MDC_DIM_KILO_PASCAL^MDC | | |
| Diastolic | 266016^MDC_DIM_MMHG^MDC or 265987^MDC_DIM_KILO_PASCAL^MDC | | |
| Mean arterial pressure | 266016^MDC_DIM_MMHG^MDC or 265987^MDC_DIM_KILO_PASCAL^MDC | | |
| Pulse rate | 264864^MDC_DIM_BEAT_PER_MIN^MDC | | |

### E.3.3 10408 Thermometer

#### E.3.3.1 Modelling

The single attribute is modelled as a metric of the thermometer object.

#### E.3.3.2 Transformations

The following transformations are performed in the encoding of this device.

#### E.3.3.3 Containment tree

Table E.10 shows a thermometer containment tree.

**Table E.10 – Thermometer containment tree**

| REFID | Description |
|---|---|
| `MDC_DEV_SPEC_PROFILE_TEMP` | Thermometer MDS |
| `... MDC_TEMP_AXILLA or`<br>`... MDC_TEMP_BODY or`<br>`... MDC_TEMP_EAR or`<br>`... MDC_TEMP_FINGER or`<br>`... MDC_TEMP_GIT or`<br>`... MDC_TEMP_ORAL or`<br>`... MDC_TEMP_RECT or`<br>`... MDC_TEMP_TOE or`<br>`... MDC_TEMP_TYMP` | Temperature |

#### E.3.3.5 OBX encoding

Table E.11 and Table E.12 show part 1 and part 2 of a thermometer encoding.

**Table E.11 – Thermometer encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| Thermometer MDS | | 528392^MDC_DEV_SPEC_PROFILE_TEMP^MDC | 1 | |
| Temperature | NM | 188452^MDC_TEMP_AXILLA^MDC or<br>150364^MDC_TEMP_BODY^MDC or<br>188428^MDC_TEMP_EAR^MDC or<br>188432^MDC_TEMP_FINGER^MDC or<br>188456^MDC_TEMP_GIT^MDC or<br>188424^MDC_TEMP_ORAL^MDC or<br>188420^MDC_TEMP_RECT^MDC or<br>188448^MDC_TEMP_TOE^MDC or<br>150392^MDC_TEMP_TYMP^MDC | 1.0.0.1 | 98.6 |

**Table E.12 – Thermometer encoding – Part 2**

| Description | OBX-6 | OBX-18 | OBX-20 |
|---|---|---|---|
| Thermometer MDS | | 0123456789ABCDEF^^0123456789<br>ABCDEF^EUI-64 | |
| Temperature | 268192^MDC_DIM_DEGC^MDC or<br>266560^MDC_DIM_FAHR^MDC | | |

### E.3.4 10415 Weighing scales

#### E.3.4.1 Modelling

All attributes are metrics of the weighing scales object.

#### E.3.4.2 Transformations

The following transformations are performed in the encoding of this device specialization.

### E.3.4.3 Containment tree

Table E.13 shows a weighing scales containment tree.

**Table E.13 – Weighing scales containment tree**

| REFID | Description |
|---|---|
| MDC_DEV_SPEC_PROFILE_SCALE | Weighing scales MDS |
| ... MDC_MASS_BODY_ACTUAL | Body weight |
| ... MDC_LEN_BODY_ACTUAL | Body height |
| ... MDC_RATIO_MASS_BODY_LEN_SQ | Body Mass Index |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding body weight |

### E.3.4.4 OBX encoding

Table E.14 and Table E.15 show part 1 and part 2 (respectively) of a weighing scales encoding.

**Table E.14 – Weighing scales encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| Weighing scales MDS | | 528399^MDC_DEV_SPEC_PROFILE_SCALE^MDC | 1 | |
| Body weight | NM | 188736^MDC_MASS_BODY_ACTUAL^MDC | 1.0.0.1 | 155.4 |
| Body height | NM | 188740^MDC_LEN_BODY_ACTUAL^MDC | 1.0.0.2 | |
| Body Mass Index | NM | 188752^MDC_RATIO_MASS_BODY_LEN_SQ^MDC | 1.0.0.3 | 25.3 |
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_REF^MDC | 1.0.0.3.1 | 1.0.0.1 |

**Table E.15 – Weighing scales encoding – Part 2**

| Description | OBX-6 | OBX-18 | OBX-20 |
|---|---|---|---|
| Weighing scales MDS | | 0123456789ABCDEF^^0123456789ABCDEF^EUI-64 | |
| Body weight | 263875^MDC_DIM_KILO_G^MDC | | |
| Body height | 263441^MDC_DIM_CENTI_M^MDC or 263520^MDC_DIM_INCH^MDC | | |
| Body Mass Index | 264096^MDC_DIM_KG_PER_M_SQ^MDC | | |
| Source-Handle-Reference | | | |

### E.3.5 10417 Glucose meter

#### E.3.5.1 Modelling

The glucose meter object model consists largely of two key observation types, blood glucose and HbA1c. Contextual objects which may provide additional information to these values **may** be linked to a particular source observation through a Source-Handle-Reference FACET-level OBX.

#### E.3.5.2 Transformations

The following transformations are performed in the encoding of this device.

Several nomenclature codes have been harmonized with the underlying base codes. These are pointed out in the tables below.

#### E.3.5.3 Containment tree

Table E.16 shows a glucose meter containment tree.

**Table E.16 – Glucose meter containment tree**

| REFID | Description |
|---|---|
| MDC_DEV_SPEC_PROFILE_GLUCOSE | Glucose meter MDS |
| `... MDC_CONC_GLU_CAPILLARY_WHOLEBLOOD or`<br>`... MDC_CONC_GLU_CAPILLARY_PLASMA or`<br>`... MDC_CONC_GLU_VENOUS_WHOLEBLOOD or` | Blood glucose |

**Table E.16 – Glucose meter containment tree**

| REFID | Description |
|---|---|
| ... MDC_CONC_GLU_VENOUS_PLASMA or<br>... MDC_CONC_GLU_ARTERIAL_WHOLEBLOOD or<br>... MDC_CONC_GLU_ARTERIAL_PLASMA or<br>... MDC_CONC_GLU_UNDETERMINED_WHOLEBLOOD or<br>... MDC_CONC_GLU_UNDETERMINED_PLASMA or<br>... MDC_CONC_GLU_ISF | |
| ... MDC_CONC_GLU_CONTROL | Control solution |
| ... MDC_CTXT_GLU_EXERCISE | Context exercise |
| .... MDC_ATTR_TIME_PD_MSMT_ACTIVE | Measure active period |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding glucose measurement |
| ... MDC_CTXT_MEDICATION is the generic code or<br>if specific Metric-Id is specified use it…<br>... MDC_CTXT_MEDICATION_RAPIDACTING or<br>... MDC_CTXT_MEDICATION_SHORTACTING or<br>... MDC_CTXT_MEDICATION_INTERMEDIATEACTING or<br>... MDC_CTXT_MEDICATION_LONGACTING or<br>... MDC_CTXT_MEDICATION_PREMIX | Context medication |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding glucose measurement |
| ... MDC_CTXT_GLU_CARB is the generic code or<br>if specific Metric-Id is specified use it…<br>... MDC_CTXT_GLU_CARB_BREAKFAST or<br>... MDC_CTXT_GLU_CARB_LUNCH or<br>... MDC_CTXT_GLU_CARB_DINNER or<br>... MDC_CTXT_GLU_CARB_SNACK or | Context carbohydrates |

**Table E.16 – Glucose meter containment tree**

| REFID | Description |
|---|---|
| ... MDC_CTXT_GLU_CARB_DRINK or<br>... MDC_CTXT_GLU_CARB_SUPPER or<br>... MDC_CTXT_GLU_CARB_BRUNCH | |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding glucose measurement |
| ... MDC_GLU_METER_DEV_STATUS | Device and sensor annunciation status |
| ... MDC_CTXT_GLU_MEAL | Context meal |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding glucose measurement |
| ... MDC_CTXT_GLU_SAMPLELOCATION | Context sample location |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding glucose measurement |
| ... MDC_CTXT_GLU_TESTER | Context tester |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding glucose measurement |
| ... MDC_CTXT_GLU_HEALTH | Context health |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding glucose measurement |
| ... MDC_CONC_HBA1C | HbA1c |

#### E.3.5.4 OBX encoding

Table E.17 andTable E.18 show part 1 and part 2 (respectively) of a glucose meter encoding.

**Table E.17 – Glucose meter encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| Glucose meter MDS | | 528401^MDC_DEV_SPEC_PROFILE_SCALE^MDC | 1 | |
| Blood glucose | NM | 160184^MDC_CONC_GLU_CAPILLARY_WHOLEBLOOD^MDC or<br>160188^MDC_CONC_GLU_CAPILLARY_PLASMA^MDC or<br>160192^MDC_CONC_GLU_VENOUS_WHOLEBLOOD^MDC or<br>160196^MDC_CONC_GLU_VENOUS_PLASMA^MDC or<br>160200^MDC_CONC_GLU_ARTERIAL_WHOLEBLOOD^MDC or<br>160204^MDC_CONC_GLU_ARTERIAL_PLASMA^MDC or<br>160364^MDC_CONC_GLU_UNDETERMINED_WHOLEBLOOD or<br>160368^MDC_CONC_GLU_UNDETERMINED_PLASMA or<br>160212^MDC_CONC_GLU_ISF^MDC | 1.0.0.1 | 37.5 |
| Control solution | NM | 160208^MDC_CONC_GLU_CONTROL^MDC | 1.0.0.2 | 37.5 |
| Context exercise | NM | 8417760^MDC_CTXT_GLU_EXERCISE^MDC | 1.0.0.3 | 77.7 |
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_REF^MDC | 1.0.0.3.1 | 1.0.0.1 |
| Measure active period | NM | 68185^MDC_ATTR_TIME_PD_MSMT_ACTIVE^MDC | 1.0.0.3.2 | 101.5 |
| Context medication | NM | 8417796^MDC_CTXT_MEDICATION^MDC or<br>8417800^MDC_CTXT_MEDICATION_RAPIDACTING^MDC or<br>8417804^MDC_CTXT_MEDICATION_SHORTACTING^MDC or<br>8417808^MDC_CTXT_MEDICATION_INTERMEDIATEACTING^MDC or<br>8417812^MDC_CTXT_MEDICATION_LONGACTING^MDC or<br>8417816^MDC_CTXT_MEDICATION_PREMIX^MDC | 1.0.0.4 | 33.3 |

**Table E.17 – Glucose meter encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_REF^MDC | 1.0.0.4.1 | 1.0.0.1 |
| Context carbohydrates | NM | 8417764^MDC_CTXT_GLU_CARB^MDC is the generic code or if specific Metric-Id is specified use it…<br>8417768^MDC_CTXT_GLU_CARB_BREAKFAST^MDC or<br>8417772^MDC_CTXT_GLU_CARB_LUNCH^MDC or<br>8417776^MDC_CTXT_GLU_CARB_DINNER^MDC or<br>8417780^MDC_CTXT_GLU_CARB_SNACK^MDC or<br>8417784^MDC_CTXT_GLU_CARB_DRINK^MDC or<br>8417788^MDC_CTXT_GLU_CARB_SUPPER^MDC or<br>8417792^MDC_CTXT_GLU_CARB_BRUNCH^MDC | 1.0.0.5 | 15.7 |
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_REF^MDC | 1.0.0.5.1 | 1.0.0.1 |
| Device and sensor annunciation status | CWE | 8417752^MDC_GLU_METER_DEV_STATUS^MDC | 1.0.0.6 | Any of the following value...<br><0 or 1>^device-battery-low(0),<br><0 or 1>^sensor-malfunction(1),<br><0 or 1>^sensor-sample-size-insufficient(2)<br><0 or 1>^sensor-strip-insertion(3),<br><0 or 1>^sensor-strip-type-incorrect(4),<br><0 or 1>^sensor-result-too-high(5),<br><0 or 1>^sensor-result-too-low(6),<br><0 or 1>^sensor-temp-too-high(7),<br><0 or 1>^sensor-temp-too-low(8),<br><0 or 1>^sensor-read-interrupt(9),<br><0 or 1>^device-gen-fault(10) |

## Table E.17 – Glucose meter encoding – Part 1

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| Context meal | CWE | 8417864^MDC_CTXT_GLU_MEAL^MDC | 1.0.0.7 | 8417868^MDC_CTXT_GLU_MEAL_PREPRANDIAL^MDC or<br>8417872^MDC_CTXT_GLU_MEAL_POSTPRANDIAL^MDC or<br>8417876^MDC_CTXT_GLU_MEAL_FASTING^MDC or<br>8417880^MDC_CTXT_GLU_MEAL_CASUAL^MDC<br>8417869^MDC_CTXT_GLU_MEAL_BEDTIME^MDC |
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_REF^MDC | 1.0.0.7.1 | 1.0.0.1 |
| Context sample location | CWE | 8417844^MDC_CTXT_GLU_SAMPLELOCATION^MDC | 1.0.0.8 | 8417848^MDC_CTXT_GLU_SAMPLELOCATION_FINGER^MDC or<br>8417852^MDC_CTXT_GLU_SAMPLELOCATION_AST^MDC or<br>8417856^MDC_CTXT_GLU_SAMPLELOCATION_EARLOBE^MDC or<br>8417860^MDC_CTXT_GLU_SAMPLELOCATION_CTLSOLUTION^MDC |
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_REF^MDC | 1.0.0.8.1 | 1.0.0.1 |

### Table E.17 – Glucose meter encoding – Part 1

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| Context tester | CWE | 8417884^MDC_CTXT_GLU_TESTER^MDC<br>is the generic code or if specific Metric-Id is specified use it…<br>8417888^MDC_CTXT_GLU_TESTER_SELF^MDC or<br>8417892^MDC_CTXT_GLU_TESTER_HCP^MDC or<br>8417896^MDC_CTXT_GLU_TESTER_LAB^MDC | 1.0.0.9 | |
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_REF^MDC | 1.0.0.9.1 | 1.0.0.1 |
| Context health | CWE | 8417820^MDC_CTXT_GLU_HEALTH^MDC | 1.0.0.10 | 8417824^MDC_CTXT_GLU_HEALTH_MINOR^MDC or<br>8417828^MDC_CTXT_GLU_HEALTH_MAJOR^MDC or<br>8417832^MDC_CTXT_GLU_HEALTH_MENSES^MDC or<br>8417836^MDC_CTXT_GLU_HEALTH_STRESS^MDC or<br>8417840^MDC_CTXT_GLU_HEALTH_NONE^MDC |
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_REF^MDC | 1.0.0.10.1 | 1.0.0.4 |
| HbA1c | NM | 160220^MDC_CONC_HBA1C^MDC | 1.0.0.11 | 77.7 |

**Table E.18 – Glucose meter encoding – part 2**

| Description | OBX-6 | OBX-18 | OBX-20 |
|---|---|---|---|
| Glucose meter MDS | | 0123456789ABCDEF^^0123456789ABCDEF^EUI-64 | |
| Blood glucose | 264274^MDC_DIM_MILLI_G_PER_DL^MDC or 266866^MDC_DIM_MILLI_MOLE_PER_L^MDC | | |
| Context exercise | 262688^MDC_DIM_PERCENT^MDC | | |
| Source-Handle-Reference | | | |
| Measure active period | 264320^MDC_DIM_SEC^MDC | | |
| Context medication | 263890^MDC_DIM_MILLI_G^MDC or 263762^MDC_DIM_MILLI_L^MDC | | |
| Source-Handle-Reference | | | |
| Context carbohydrates | 263872^MDC_DIM_G^MDC<br>NOTE – The underlying standard uses MDC_DIM_X_G but this is translated to MDC_DIM_G for the Services interface usage | | |
| Source-Handle-Reference | | | |
| Device and sensor annunciation status | | | |
| Context meal | | | |
| Source-Handle-Reference | | | |
| Context sample location | | | |
| Source-Handle-Reference | | | |
| Context tester | | | |
| Source-Handle-Reference | | | |
| Context health | | | |
| Source-Handle-Reference | | | |
| HbA1c | 262688^MDC_DIM_PERCENT^MDC | | |

### E.3.6 10418 INR meter

#### E.3.6.1 Modelling

The INR meter object model consists of one key observation type, INR. Contextual objects which may provide additional information to these values **may** be linked to a particular source observation through a Source-Handle-Reference FACET-level OBX.

#### E.3.6.2 Transformations

The following transformations are performed in the encoding of this device.

Several nomenclature codes have been harmonized with the underlying base codes. These are pointed out in the tables below.

#### E.3.6.3 Containment tree

Table E.19 shows an INR meter containment tree.

**Table E.19 – INR meter containment tree**

| REFID | Description |
|---|---|
| MDC_DEV_SPEC_PROFILE_COAG | INR meter MDS |
| ... MDC_RATIO_INR_COAG or<br>... MDC_TIME_PD_COAG or<br>... MDC_QUICK_VALUE_COAG | INR |
| ... MDC_COAG_CONTROL | Control solution |
| ... MDC_ISI_COAG | International Sensitivity Index (ISI) |
| ... MDC_INR_METER_DEV_STATUS | Device and sensor annunciation status |
| ... MDC_CTXT_INR_TESTER | Context tester |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding INR measurement |

### E.3.6.4 OBX encoding

Table E.20 and Table E.21 show part 1 and part 2 (respectively) of an INR meter encoding.

**Table E.20 – INR meter encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| INR meter MDS | | 528406^MDC_DEV_SPEC_PROFILE_COAG^MDC | 1 | |
| INR | NM | 160260^MDC_RATIO_INR_COAG^MDC or<br>160264^MDC_TIME_PD_COAG^MDC or<br>160268^MDC_QUICK_VALUE_COAG^MDC | 1.0.0.1 | 1.5 |
| Control solution | NM | 160276^MDC_CONC_INR_CONTROL^MDC | 1.0.0.2 | 2.5 |
| ISI | NM | 160272^MDC_COAG^MDC | 1.0.0.3 | |
| Context tester | | 8417924^MDC_CTXT_INR_TESTER^MDC<br>is the generic code or if specific Metric-Id is specified use it…<br>8417925^MDC_CTXT_INR_TESTER_SELF^MDC or<br>8417926^MDC_CTXT_INR_TESTER_HCP^MDC or<br>8417927^MDC_CTXT_INR_TESTER_LAB^MDC | 1.0.0.4 | |
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_REF^MDC | 1.0.0.4.1 | 1.0.0.1 |

**Table E.21 – INR meter encoding – Part 2**

| Description | OBX-6 | OBX-18 | OBX-20 |
|---|---|---|---|
| INR meter MDS | | 0123456789ABCDEF^^0123456789ABCDEF^EUI-64 | |
| INR | 268752^MDC_DIM_INR^MDC or<br>264320^MDC_DIM_SEC^MDC or<br>262688^MDC_DIM_PERCENT^MDC | | |
| Control solution | 268752^MDC_DIM_INR^MDC | | |
| ISI | 262656^MDC_DIM_DIMLESS^MDC | | |
| Context tester | | | |
| Source-Handle-Reference | | | |

### E.3.7 10441 Cardiovascular fitness and activity monitor

#### E.3.7.1 Modelling

All observations for this device belong to sessions or subsessions. This natural hierarchy is expressed through the PCD-01 containment hierarchy and shown in the following tables.

#### E.3.7.2 Transformations

The following transformations are performed in the encoding of this device.

Several nomenclature codes have been harmonized with the underlying base codes. These are pointed out in the tables below.

#### E.3.7.3 Containment tree

Table E.22 shows a cardiovascular fitness and activity monitor containment tree.

**Table E.22 – Cardiovascular fitness and activity monitor containment tree**

| REFID | Description |
|---|---|
| MDC_DEV_SPEC_PROFILE_HF_CARDIO | Cardiovascular fitness and activity monitor MDS |
| ... MDC_HF_SESSION | Session |
| .... MDC_ATTR_TIME_PD_MSMT_ACTIVE | Measure active period (Session) |
| ... MDC_HF_SUBSESSION | Subsession |
| .... MDC_ATTR_TIME_PD_MSMT_ACTIVE | Measure active period (Subsession) |
| ... MDC_HF_ALT_LOSS | Altitude loss |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding session |
| ... MDC_HF_ALT | Altitude |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding session |
| ... MDC_HF_DISTANCE | Distance |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding session |

**Table E.22 – Cardiovascular fitness and activity monitor containment tree**

| REFID | Description |
|---|---|
| ... MDC_HF_ASC_TIME_DIST | Ascent time and distance |
| .... MDC_ATTR_TIME_PD_MSMT_ACTIVE | Measure active period |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding session |
| ... MDC_HF_DESC_TIME_DIST | Descent time and distance |
| .... MDC_ATTR_TIME_PD_MSMT_ACTIVE | Measure active period |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding session |
| ... MDC_HF_LATITUDE | Latitude |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding session |
| ... MDC_HF_LONGITUDE | Longitude |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding session |
| ... MDC_HF_SLOPES | Slopes |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding session |
| ... MDC_HF_SPEED | Speed |
| .... MDC_ATTR_ID_PHYSIO | Measurement type (Speed) |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding session |
| ... MDC_HF_CAD | Cadence |
| .... MDC_ATTR_ID_PHYSIO | Measurement type (Cadence) |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding session |

**Table E.22 – Cardiovascular fitness and activity monitor containment tree**

| REFID | Description |
|---|---|
| ... MDC_HF_INCLINE | Incline |
| .... MDC_ATTR_ID_PHYSIO | Measurement type (Incline) |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding session |
| ... MDC_HF_HR | Heart rate |
| .... MDC_ATTR_ID_PHYSIO | Measurement type (Heart Rate) |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding session |
| ... MDC_HF_HR_MAX_USER | Max user heart rate |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding session |
| ... MDC_HF_POWER | Power |
| .... MDC_ATTR_ID_PHYSIO | Measurement type (Power) |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding session |
| ... MDC_HF_RESIST | Resistance |
| .... MDC_ATTR_ID_PHYSIO | Measurement type (Resistance) |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding session |
| ... MDC_HF_STRIDE | Stride length |
| .... MDC_ATTR_ID_PHYSIO | Measurement type (Stride length) |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding session |
| ... MDC_RESP_RATE | Breathing rate |
| .... MDC_ATTR_ID_PHYSIO | Measurement type (Breathing rate) |

**Table E.22 – Cardiovascular fitness and activity monitor containment tree**

| REFID | Description |
|---|---|
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding session |
| ... MDC_HF_ENERGY | Energy expended |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding session |
| ... MDC_HF_CAL_INGEST | Calories ingested |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding session |
| ... MDC_HF_CAL_INGEST_CARB | Carbohydrate calories ingested |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding session |
| ... MDC_HF_SUST_PA_THRESHOLD | Sustained phys activity threshold |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding session |
| ... MDC_HF_ACTIVITY_INTENSITY | Activity intensity |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding session |
| ... MDC_MASS_BODY_ACTUAL | Body weight |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding session |
| ... MDC_LEN_BODY_ACTUAL | Height |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding session |
| ... MDC_HF_AGE | Age |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference |

**Table E.22 – Cardiovascular fitness and activity monitor containment tree**

| REFID | Description |
|---|---|
| | Reference to the corresponding session |
| ... MDC_HF_ACTIVITY_TIME | Activity time |
| .... MDC_ATTR_TIME_PD_MSMT_ACTIVE | Measure active period (Activity time) |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding session |
| ... MDC_HF_PROGRAM_ID | Program identifier |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding session |

### E.3.7.4 OBX encoding

Table E.23 and Table E.24 show part 1 and part 2 (respectively) of a cardiovascular fitness and activity monitor encoding.

**Table E.23 – Cardiovascular fitness and activity monitor encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| Cardiovascular fitness and activity monitor MDS | | 528425^MDC_DEV_SPEC_PROFILE_HF_CARDIO^MDC | 1 | |
| Session | CWE | 8454267^MDC_HF_SESSION^MDC | 1.0.0.1 | Any of the MDC_HF_ACT_* values defined in 10441. For example…<br>8455155^MDC_HF_ACT_RUN^MDC |
| Measure active period (Session) | NM | 68185^MDC_ATTR_TIME_PD_MSMT_ACTIVE^MDC | 1.0.0.1.1 | 25 |
| Subsession | CWE | 8454268^MDC_HF_SUBSESSION^MDC | 1.0.0.2 | Any of the MDC_HF_ACT_* values defined in 10441. For example…<br>8455155^MDC_HF_ACT_RUN^MDC |

Table E.23 – Cardiovascular fitness and activity monitor encoding – Part 1

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| Measure active period (Subsession) | NM | 68185^MDC_ATTR_TIME_PD_MSMT_ACTIVE^MDC | 1.0.0.2.1 | 25 |
| Altitude gain | NM | 8454244^MDC_HF_ALT_GAIN^MDC | 1.0.0.3 | 10 |
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_REF^MDC | 1.0.0.3.1 | 1.0.0.2 |
| Altitude loss | NM | 8454245^MDC_HF_ALT_LOSS^MDC | 1.0.0.4 | 10 |
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_REF^MDC | 1.0.0.4.1 | 1.0.0.2 |
| Altitude | NM | 8454246^MDC_HF_ALT^MDC | 1.0.0.5 | 10 |
| Distance | NM | 8454247^MDC_HF_DISTANCE^MDC | 1.0.0.6 | 10 |
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_REF^MDC | 1.0.0.6.1 | 1.0.0.2 |
| Ascent time and distance | NM | 8454248^MDC_HF_ASC_TIME_DIST^MDC | 1.0.0.7 | 10 |
| Measure active period | NM | 68185^MDC_ATTR_TIME_PD_MSMT_ACTIVE^MDC | 1.0.0.7.1 | 25 |
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_REF^MDC | 1.0.0.7.2 | 1.0.0.2 |
| Descent time and distance | NM | 8454249^MDC_HF_DESC_TIME_DIST^MDC | 1.0.0.8 | 10 |
| Measure active period | NM | 68185^MDC_ATTR_TIME_PD_MSMT_ACTIVE^MDC | 1.0.0.8.1 | 25 |
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_REF^MDC | 1.0.0.8.2 | 1.0.0.2 |
| Latitude | NM | 8454250^MDC_HF_LATITUDE^MDC | 1.0.0.9 | 53.2 |
| Source-Handle- | ST | 68167^MDC_ATTR_SOURCE_HANDLE_REF^MDC | 1.0.0.9.1 | 1.0.0.2 |

**Table E.23 – Cardiovascular fitness and activity monitor encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| Reference | | | | |
| Longitude | NM | 8454251^MDC_HF_LONGITUDE^MDC | 1.0.0.10 | 67.7 |
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_REF^MDC | 1.0.0.10.1 | 1.0.0.2 |
| Slopes | NM | 8454253^MDC_HF_SLOPES^MDC | 1.0.0.11 | 11 |
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_REF^MDC | 1.0.0.11.1 | 1.0.0.2 |
| Speed | NM | 8454254^MDC_HF_SPEED^MDC | 1.0.0.12 | 37.3 |
| Measurement type (Speed) | CWE | 67883^MDC_ATTR_ID_PHYSIO^MDC | 1.0.0.12.1 | 8456144^MDC_HF_MEAN_NULL_EXCLUDE^MDC or<br>8456145^MDC_HF_MEAN_NULL_INCLUDE^MDC or<br>8456146^MDC_HF_MAX^MDC or<br>8456147^MDC_HF_MIN^MDC |
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_REF^MDC | 1.0.0.12.2 | 1.0.0.2 |
| Cadence | NM | 8454255^MDC_HF_CAD^MDC | 1.0.0.13 | 55 |
| Measurement type (Cadence) | CWE | 67883^MDC_ATTR_ID_PHYSIO^MDC | 1.0.0.13.1 | 8456144^MDC_HF_MEAN_NULL_EXCLUDE^MDC or<br>8456145^MDC_HF_MEAN_NULL_INCLUDE^MDC or<br>8456146^MDC_HF_MAX^MDC or<br>8456147^MDC_HF_MIN^MDC |
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_REF^MDC | 1.0.0.13.2 | 1.0.0.2 |
| Incline | NM | 8454256^MDC_HF_INCLINE^MDC | 1.0.0.14 | 12.7 |
| Measurement | CWE | 67883^MDC_ATTR_ID_PHYSIO^MDC | 1.0.0.14.1 | 8456144^MDC_HF_MEAN_NULL_EXCLUDE^MDC |

**Table E.23 – Cardiovascular fitness and activity monitor encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| type (Incline) | | | | or<br>8456145^MDC_HF_MEAN_NULL_INCLUDE^MDC or<br>8456146^MDC_HF_MAX^MDC or<br>8456147^MDC_HF_MIN^MDC |
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_REF^MDC | 1.0.0.14.2 | 1.0.0.2 |
| Heart rate | NM | 8454258^MDC_HF_HR^MDC | 1.0.0.15 | 77 |
| Measurement type (Heart rate) | CWE | 67883^MDC_ATTR_ID_PHYSIO^MDC | 1.0.0.15.1 | 8456144^MDC_HF_MEAN_NULL_EXCLUDE^MDC or<br>8456145^MDC_HF_MEAN_NULL_INCLUDE^MDC or<br>8456146^MDC_HF_MAX^MDC or<br>8456147^MDC_HF_MIN^MDC |
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_REF^MDC | 1.0.0.15.2 | 1.0.0.2 |
| Max user heart rate | NM | 8454257^MDC_HF_HR_MAX_USER^MDC | 1.0.0.16 | 99 |
| Power | NM | 8454259^MDC_HF_POWER^MDC | 1.0.0.17 | 154.2 |
| Measurement type (Power) | CWE | 67883^MDC_ATTR_ID_PHYSIO^MDC | 1.0.0.17.1 | 8456144^MDC_HF_MEAN_NULL_EXCLUDE^MDC or<br>8456145^MDC_HF_MEAN_NULL_INCLUDE^MDC or<br>8456146^MDC_HF_MAX^MDC or<br>8456147^MDC_HF_MIN^MDC |
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_REF^MDC | 1.0.0.17.2 | 1.0.0.2 |
| Resistance | NM | 8454260^MDC_HF_RESIST^MDC | 1.0.0.18 | 55 |

**Table E.23 – Cardiovascular fitness and activity monitor encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| Measurement type (Power) | CWE | 67883^MDC_ATTR_ID_PHYSIO^MDC | 1.0.0.18.1 | 8456144^MDC_HF_MEAN_NULL_EXCLUDE^MDC or<br>8456145^MDC_HF_MEAN_NULL_INCLUDE^MDC or<br>8456146^MDC_HF_MAX^MDC or<br>8456147^MDC_HF_MIN^MDC |
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_REF^MDC | 1.0.0.18.2 | 1.0.0.2 |
| Stride length | NM | 8454261^MDC_HF_STRIDE^MDC | 1.0.0.19 | 56.6 |
| Measurement type (Power) | CWE | 67883^MDC_ATTR_ID_PHYSIO^MDC | 1.0.0.19.1 | 8456144^MDC_HF_MEAN_NULL_EXCLUDE^MDC or<br>8456145^MDC_HF_MEAN_NULL_INCLUDE^MDC or<br>8456146^MDC_HF_MAX^MDC or<br>8456147^MDC_HF_MIN^MDC |
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_REF^MDC | 1.0.0.19.2 | 1.0.0.2 |
| Breathing rate | NM | 151562^MDC_RESP_RATE^MDC | 1.0.0.20 | 51 |
| Measurement type (Breathing rate) | CWE | 67883^MDC_ATTR_ID_PHYSIO^MDC | 1.0.0.20.1 | 8456144^MDC_HF_MEAN_NULL_EXCLUDE^MDC or<br>8456145^MDC_HF_MEAN_NULL_INCLUDE^MDC or<br>8456146^MDC_HF_MAX^MDC or<br>8456147^MDC_HF_MIN^MDC |
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_REF^MDC | 1.0.0.20.2 | 1.0.0.2 |
| Energy expended | NM | 8454263^MDC_HF_ENERGY^MDC | 1.0.0.21 | 523.1 |

**Table E.23 – Cardiovascular fitness and activity monitor encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_REF^MDC | 1.0.0.21.1 | 1.0.0.2 |
| Calories ingested | NM | 8454264^MDC_HF_CAL_INGEST^MDC | 1.0.0.22 | 837.2 |
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_REF^MDC | 1.0.0.22.1 | 1.0.0.2 |
| Carbohydrate calories ingested | NM | 8454265^MDC_HF_CAL_INGEST_CARB^MDC | 1.0.0.23 | 433.7 |
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_REF^MDC | 1.0.0.23.1 | 1.0.0.2 |
| Sustained phys activity threshold | NM | 8454266^MDC_HF_SUST_PA_THRESHOLD^MDC | 1.0.0.24 | 45.3 |
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_REF^MDC | 1.0.0.24.1 | 1.0.0.2 |
| Activity intensity | NM | 8454271^MDC_HF_ACTIVITY_INTENSITY^MDC | 1.0.0.25 | 22.2 |
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_REF^MDC | 1.0.0.25.1 | 1.0.0.2 |
| Body weight | NM | 188736^MDC_MASS_BODY_ACTUAL^MDC | 1.0.0.26 | 101.8 |
| Height | NM | 188740^MDC_LEN_BODY_ACTUAL^MDC | 1.0.0.27 | 72.0 |
| Age | NM | 8454270^MDC_HF_AGE^MDC | 1.0.0.28 | 37 |

**Table E.23 – Cardiovascular fitness and activity monitor encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| Activity time | CWE | 8454269^MDC_HF_ACTIVITY_TIME^MDC | 1.0.0.29 | 8455144^MDC_HF_ACT_AMB^MDC or<br>8455145^MDC_HF_ACT_REST^MDC or<br>8455146^MDC_HF_ACT_MOTOR^MDC or<br>8455147^MDC_HF_ACT_LYING^MDC or<br>8455148^MDC_HF_ACT_SLEEP^MDC or<br>8455149^MDC_HF_ACT_PHYS^MDC or<br>8455150^MDC_HF_ACT_SUS_PHYS^MDC or<br>8455151^MDC_HF_ACT_UNKNOWN^MDC |
| Measure active period (Activity Time) | NM | 68185^MDC_ATTR_TIME_PD_MSMT_ACTIVE^MDC | 1.0.0.29.1 | 25 |
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_REF^MDC | 1.0.0.29.2 | 1.0.0.2 |
| Program identifier | ST | 8454252^MDC_HF_PROGRAM_ID^MDC | 1.0.0.30 | "Pike's Peak hill climb" |
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_REF^MDC | 1.0.0.30.1 | 1.0.0.2 |

**Table E.24 – Cardiovascular fitness and activity monitor encoding – Part 2**

| Description | OBX-6 | OBX-18 | OBX-20 |
|---|---|---|---|
| Strength fitness equipment MDS | | 0123456789ABCDEF^^0123456789ABCDEF^EUI-64 | |
| Session | | | |

**Table E.24 – Cardiovascular fitness and activity monitor encoding – Part 2**

| Description | OBX-6 | OBX-18 | OBX-20 |
|---|---|---|---|
| Measure active period (Session) | 264320^MDC_DIM_SEC^MDC | | |
| Subsession | | | |
| Measure active period (Subsession) | 264320^MDC_DIM_SEC^MDC | | |
| Altitude gain | 263424^MDC_DIM_M^MDC or<br>263488^MDC_DIM_FOOT^MDC<br>NOTE – The underlying standard uses MDC_DIM_X_M and MDC_DIM_X_FOOT but this is translated to MDC_DIM_M and MDC_DIM_FOOT for the Services interface usage | | |
| Source-Handle-Reference | | | |
| Altitude loss | 263424^MDC_DIM_M^MDC or<br>263488^MDC_DIM_FOOT^MDC<br>NOTE – The underlying standard uses MDC_DIM_X_M and MDC_DIM_X_FOOT but this is translated to MDC_DIM_M and MDC_DIM_FOOT for the Services interface usage | | |
| Source-Handle-Reference | | | |
| Altitude | 263424^MDC_DIM_M^MDC or<br>263488^MDC_DIM_FOOT^MDC<br>NOTE – The underlying standard uses MDC_DIM_X_M and MDC_DIM_X_FOOT but this is translated to MDC_DIM_M and MDC_DIM_FOOT for the Services interface usage | | |

### Table E.24 – Cardiovascular fitness and activity monitor encoding – Part 2

| Description | OBX-6 | OBX-18 | OBX-20 |
|---|---|---|---|
| Source-Handle-Reference | | | |
| Distance | 263424^MDC_DIM_M^MDC or<br>263488^MDC_DIM_FOOT^MDC or<br>268800^MDC_DIM_STEP^MDC<br>NOTE – The underlying standard uses MDC_DIM_X_M, MDC_DIM_X_FOOT and MDC_DIM_X_STEP but this is translated to MDC_DIM_M, MDC_DIM_FOOT and MDC_DIM_STEP for the Services interface usage | | |
| Source-Handle-Reference | | | |
| Ascent time and distance | 263424^MDC_DIM_M^MDC or<br>263488^MDC_DIM_FOOT^MDC or<br>268800^MDC_DIM_STEP^MDC<br>NOTE – The underlying standard uses MDC_DIM_X_M, MDC_DIM_X_FOOT and MDC_DIM_X_STEP but this is translated to MDC_DIM_M, MDC_DIM_FOOT and MDC_DIM_STEP for the Services interface | | |
| Measure active period | 264320^MDC_DIM_SEC^MDC | | |
| Source-Handle-Reference | | | |
| Descent time and distance | 263424^MDC_DIM_M^MDC or<br>263488^MDC_DIM_FOOT^MDC or<br>268800^MDC_DIM_STEP^MDC<br>NOTE – The underlying standard uses MDC_DIM_X_M, MDC_DIM_X_FOOT and MDC_DIM_X_STEP but this is translated to MDC_DIM_M, MDC_DIM_FOOT and MDC_DIM_STEP for the Services interface | | |

Table E.24 – Cardiovascular fitness and activity monitor encoding – Part 2

| Description | OBX-6 | OBX-18 | OBX-20 |
|---|---|---|---|
| Measure active period | 264320^MDC_DIM_SEC^MDC | | |
| Source-Handle-Reference | | | |
| Latitude | 262880^MDC_DIM_ANG_DEG^MDC | | |
| Longitude | 262880^MDC_DIM_ANG_DEG^MDC | | |
| Slopes | 262656^MDC_DIM_DIMLESS^MDC | | |
| Speed | 268704^MDC_DIM_M_PER_MIN^MDC, or<br>268832^MDC_DIM_FOOT_PER_MIN^MDC, or<br>268864^MDC_DIM_INCH_PER_MIN^MDC, or<br>268896^MDC_DIM_STEP_PER_MIN^MDC<br>NOTE – The underlying standard uses MDC_DIM_X_M_PER_MIN, MDC_DIM_X_INCH_PER_MIN, MDC_DIM_X_FOOT_PER_MIN and MDC_DIM_X_STEP_PER_MIN but this is translated to MDC_DIM_M_PER_MIN, MDC_DIM_FOOT_PER_MIN, MDC_DIM_INCH_PER_MIN and MDC_DIM_STEP_PER_MIN for the Services interface | | |
| Measurement type (Speed) | | | |
| Source-Handle-Reference | | | |
| Cadence | 268960^MDC_DIM_RPM^MDC | | |
| Measurement type (Cadence) | | | |

**Table E.24 – Cardiovascular fitness and activity monitor encoding – Part 2**

| Description | OBX-6 | OBX-18 | OBX-20 |
|---|---|---|---|
| Source-Handle-Reference | | | |
| Incline | 262688^MDC_DIM_PERCENT^MDC or<br>262880^MDC_DIM_ANG_DEG^MDC | | |
| Measurement type (Incline) | | | |
| Source-Handle-Reference | | | |
| Heart rate | 264864^MDC_DIM_BEAT_PER_MIN^MDC | | |
| Measurement type (Heart rate) | | | |
| Source-Handle-Reference | | | |
| Max user heart rate | 264864^MDC_DIM_BEAT_PER_MIN^MDC | | |
| Source-Handle-Reference | | | |
| Power | 266176^MDC_DIM_WATT^MDC<br>NOTE – The underlying standard uses MDC_DIM_X_WATT but this is translated to MDC_DIM_WATT for the Services interface | | |
| Measurement type (Power) | | | |
| Source-Handle-Reference | | | |
| Resistance | Leave blank or use 262656^MDC_DIM_DIMLESS^MDC | | |
| Measurement type (Power) | | | |
| Source-Handle-Reference | | | |

Table E.24 – Cardiovascular fitness and activity monitor encoding – Part 2

| Description | OBX-6 | OBX-18 | OBX-20 |
|---|---|---|---|
| Stride length | 263424^MDC_DIM_M^MDC or<br>263520^MDC_DIM_INCH^MDC<br>NOTE – The underlying standard uses MDC_DIM_X_M and MDC_DIM_X_INCH but this is translated to MDC_DIM_M and MDC_DIM_INCH for the Services interface | | |
| Measurement type (Stride Length) | | | |
| Source-Handle-Reference | | | |
| Breathing rate | 264928^MDC_DIM_RESP_PER_MIN^MDC | | |
| Measurement type (Breathing Rate) | | | |
| Source-Handle-Reference | | | |
| Energy expended | 268928^MDC_DIM_CAL^MDC or<br>266112^MDC_DIM_JOULES^MDC<br>NOTE – The underlying standard uses MDC_DIM_X_CAL and MDC_DIM_X_JOULES but this is translated to MDC_DIM_CAL and MDC_DIM_JOULES for the Services interface | | |
| Source-Handle-Reference | | | |
| Calories ingested | 268928^MDC_DIM_CAL^MDC<br>NOTE – The underlying standard uses MDC_DIM_X_CAL but this is translated to MDC_DIM_CAL for the Services interface | | |

**Table E.24 – Cardiovascular fitness and activity monitor encoding – Part 2**

| Description | OBX-6 | OBX-18 | OBX-20 |
|---|---|---|---|
| Carbohydrate calories ingested | 268928^MDC_DIM_CAL^MDC<br>NOTE – The underlying standard uses MDC_DIM_X_CAL but this is translated to MDC_DIM_CAL for the Services interface | | |
| Source-Handle-Reference | | | |
| Sustained phys activity threshold | 264352^MDC_DIM_MIN^MDC | | |
| Source-Handle-Reference | | | |
| Activity intensity | 262688^MDC_DIM_PERCENT^MDC | | |
| Source-Handle-Reference | | | |
| Body weight | 263872^MDC_DIM_G^MDC or<br>263904^MDC_DIM_LB^MDC<br>NOTE – The underlying standard uses DIM_X_G and MDC_DIM_X_LB but this is translated to MDC_DIM_G and MDC_DIM_LB for the Services interface | | |
| Height | 263424^MDC_DIM_M^MDC or<br>263488^MDC_DIM_FOOT^MDC<br>NOTE – The underlying standard uses MDC_DIM_X_M and MDC_DIM_X_FOOT but this is translated to MDC_DIM_M and MDC_DIM_FOOT for the Services interface | | |
| Age | 264512^MDC_DIM_YR^MDC | | |
| Activity time | | | |
| Measure active period (Activity time) | 264320^MDC_DIM_SEC^MDC | | |

**Table E.24 – Cardiovascular fitness and activity monitor encoding – Part 2**

| Description | OBX-6 | OBX-18 | OBX-20 |
|---|---|---|---|
| Source-Handle-Reference | | | |
| Program identifier | | | |
| Source-Handle-Reference | | | |

### E.3.8 10442 Strength fitness equipment

#### E.3.8.1 Modelling

All measurements for this device belong to *sets*. This natural hierarchy is expressed through the PCD-01 containment hierarchy and shown in the following tables.

#### E.3.8.2 Transformations

The following transformations are performed in the encoding of this device.

Several nomenclature codes have been harmonized with the underlying base codes. These are pointed out in the tables below.

#### E.3.8.3 Containment tree

Table E.25 shows a strength fitness equipment containment tree.

**Table E.25 – Strength fitness equipment containment tree**

| REFID | Description |
|---|---|
| MDC_DEV_SPEC_PROFILE_HF_STRENGTH | Strength fitness equipment MDS |
| ... MDC_HF_SET | Set |
| .... MDC_ATTR_TIME_PD_MSMT_ACTIVE | Measure active period |
| ... MDC_HF_REP_COUNT | Repetition count |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding session |

**Table E.25 – Strength fitness equipment containment tree**

| REFID | Description |
|---|---|
| ... MDC_HF_RESISTANCE | Resistance |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding session |
| ... MDC_HF_REPETITION | Repetition |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding session |
| ... MDC_HF_EXERCISE_POSITION | Exercise position |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding session |
| ... MDC_HF_EXERCISE_LATERALITY | Exercise laterality |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding session |
| ... MDC_HF_EXERCISE_GRIP | Exercise grip |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding session |
| ... MDC_HF_EXERCISE_MOVEMENT | Exercise movement |
| .... MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding session |

### E.3.8.4 OBX encoding

Table E.26 and Table E.27 show part 1 and part 2 (respectively) of a strength fitness equipment encoding.

**Table E.26 – Strength fitness equipment encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| Strength fitness equipment | | 528426^MDC_DEV_SPEC_PROFILE_HF_S | 1 | |

**Table E.26 – Strength fitness equipment encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| MDS | | TRENGTH^MDC | | |
| Set | NM | 8454344^MDC_HF_SET^MDC | 1.0.0.1 | |
| Measure active period | NM | 68185^MDC_ATTR_TIME_PD_MSMT_AC TIVE^MDC | 1.0.0.1.1 | 25.3 |
| Repetition count | NM | 8454346^MDC_HF_REPETITION_COUNT^ MDC | 1.0.0.2 | 50 |
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_R EF^MDC | 1.0.0.2.1 | 1.0.0.1 |
| Resistance | NM | 8454347^MDC_HF_RESISTANCE^MDC | 1.0.0.3 | 25 |
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_R EF^MDC | 1.0.0.3.1 | 1.0.0.1 |
| Repetition | NM | 8454345^MDC_HF_REPETITION^MDC | 1.0.0.4 | 10 |
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_R EF^MDC | 1.0.0.4.1 | 1.0.0.1 |
| Exercise position | CWE | 8454348^MDC_HF_EXERCISE_POSITION ^MDC | 1.0.0.5 | Any of the exercise position values defined in 10442. For example… 8455347^MDC_HF_POSITION_INCLINE^MDC |
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_R EF^MDC | 1.0.0.5.1 | 1.0.0.1 |
| Exercise laterality | CWE | 8454349^MDC_HF_EXERCISE_LATERALI TY^MDC | 1.0.0.6 | Any of the exercise laterality values defined in 10442. For example… 8455345^MDC_HF_LATERALITY_RIGHT^MD C |
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_R EF^MDC | 1.0.0.6.1 | 1.0.0.1 |
| Exercise grip | CWE | 8454350^MDC_HF_EXERCISE_GRIP^MD C | 1.0.0.7 | Any of the grip values defined in 10442. For example… 8455546^MDC_HF_GRIP_UNDERHAND^MDC |

**Table E.26 – Strength fitness equipment encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_REF^MDC | 1.0.0.7.1 | 1.0.0.1 |
| Exercise movement | CWE | 8454351^MDC_HF_EXERCISE_MOVEMENT^MDC | 1.0.0.8 | Any of the movement values defined in 10442. For example…<br>8455446^MDC_HF_MOVEMENT_ROTATION^MDC |
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_REF^MDC | 1.0.0.8.1 | 1.0.0.1 |

**Table E.27 – Strength fitness equipment encoding – Part 2**

| Description | OBX-6 | OBX-18 | OBX-20 |
|---|---|---|---|
| Strength fitness equipment MDS | | 0123456789ABCDEF^^0123456789ABCDEF^EUI-64 | |
| Set | | | Any of the muscle sites defined in 10442. For example…<br>459284^MDC_MUSC_THORAX_PECTORAL_MAJOR^MDC |
| Measure active period | 264320^MDC_DIM_SEC^MDC | | |
| Repetition count | Leave blank or 262656^MDC_DIM_DIMLESS^MDC | | |
| Source-Handle-Reference | | | |
| Resistance | 262656^MDC_DIM_DIMLESS^MDC or<br>263872^MDC_DIM_G^MDC or<br>263904^MDC_DIM_LB^MDC<br>NOTE – The underlying standard uses MDC_DIM_X_G but this is translated to | | |

**Table E.27 – Strength fitness equipment encoding – Part 2**

| Description | OBX-6 | OBX-18 | OBX-20 |
|---|---|---|---|
| | MDC_DIM_G for the Services interface | | |
| Source-Handle-Reference | | | |
| Repetition | 263424^MDC_DIM_M^MDC or<br>263520^MDC_DIM_INCH^MDC<br>NOTE – The underlying standard uses MDC_DIM_X_M and MDC_DIM_X_INCH but this is translated to MDC_DIM_M and MDC_DIM_INCH for the Services interface | | |
| Source-Handle-Reference | | | |
| Exercise position | | | |
| Source-Handle-Reference | | | |
| Exercise laterality | | | |
| Source-Handle-Reference | | | |
| Exercise grip | | | |
| Source-Handle-Reference | | | |
| Exercise movement | | | |
| Source-Handle-Reference | | | |

### E.3.9 10471 Independent living activity hub

#### E.3.9.1 Modelling

Sensor values are reported using the AI type codes and their bitstring values. Optionally, a FACET value may be transmitted to indicate the sensor identifier and location.

#### E.3.9.2 Transformations

The following transformations are performed in the encoding of this device.

– MDC_ATTR_SUPPLEMENTAL_TYPES should be replaced by MDC_AI_LOCATION for Services transmission.

– MDC_ATTR_SUPPLEMENTAL_TYPES/MDC_AI_LOCATION refIdName should match the MDC_AI_LOCATION identifier given by the first 10 bits of the Supplemental-Types attribute and may append "_<room number>" to this value based upon the value of the lower 6 bits.

### E.3.9.3 Containment tree

Table E.28 shows an Independent living activity hub containment tree.

**Table E.28 – Independent living activity hub containment tree**

| REFID | Description |
|---|---|
| MDC_DEV_SPEC_PROFILE_AI_ACTIVITY_HUB | Independent living activity hub MDS |
| ... MDC_AI_TYPE_SENSOR_FALL | Fall sensor |
| .... MDC_ATTR_SUPPLEMENTAL_TYPES | Location (Fall sensor) |
| ... MDC_AI_TYPE_SENSOR_PERS | PERS sensor |
| .... MDC_ATTR_SUPPLEMENTAL_TYPES | Location (PERS sensor) |
| ... MDC_AI_TYPE_SENSOR_SMOKE | Environmental sensor – smoke |
| .... MDC_ATTR_SUPPLEMENTAL_TYPES | Location (Environmental sensor – smoke) |
| ... MDC_AI_TYPE_SENSOR_CO | Environmental sensor – CO |
| .... MDC_ATTR_SUPPLEMENTAL_TYPES | Location (Environmental sensor – CO) |
| ... MDC_AI_TYPE_SENSOR_WATER | Environmental sensor – water |
| .... MDC_ATTR_SUPPLEMENTAL_TYPES | Location (Environmental sensor – water) |
| ... MDC_AI_TYPE_SENSOR_GAS | Environmental sensor – gas |
| .... MDC_ATTR_SUPPLEMENTAL_TYPES | Location (Environmental sensor – gas) |
| ... MDC_AI_TYPE_SENSOR_MOTION | Motion sensor |
| .... MDC_ATTR_SUPPLEMENTAL_TYPES | Location (Motion sensor) |
| ... MDC_AI_TYPE_SENSOR_PROPEXIT | Property exit sensor |
| .... MDC_ATTR_SUPPLEMENTAL_TYPES | Location (Exit sensor) |
| ... MDC_AI_TYPE_SENSOR_ENURESIS | Enuresis sensor |
| .... MDC_ATTR_SUPPLEMENTAL_TYPES | Location (Enuresis sensor) |
| ... MDC_AI_TYPE_SENSOR_CONTACTCLOSURE | Contact closure sensor |

**Table E.28 – Independent living activity hub containment tree**

| REFID | Description |
|---|---|
| .... MDC_ATTR_SUPPLEMENTAL_TYPES | Location (Contact closure sensor) |
| ... MDC_AI_TYPE_SENSOR_USAGE | Usage sensor |
| .... MDC_ATTR_SUPPLEMENTAL_TYPES | Location (Usage sensor) |
| ... MDC_AI_TYPE_SENSOR_SWITCH | Switch sensor |
| .... MDC_ATTR_SUPPLEMENTAL_TYPES | Location (Switch sensor) |
| ... MDC_AI_TYPE_SENSOR_DOSAGE | Medication dosage sensor |
| .... MDC_ATTR_SUPPLEMENTAL_TYPES | Location (Dosage sensor) |
| ... MDC_AI_TYPE_SENSOR_TEMP | Temperature sensor |
| .... MDC_ATTR_SUPPLEMENTAL_TYPES | Location (Temperature sensor) |

### E.3.9.4 OBX encoding

Table E.29 and Table E.30 show part 1 and part 2 (respectively) of an independent living activity hub encoding.

**Table E.29 – Independent living activity hub encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| Independent living activity hub MDS | | 528455^MDC_DEV_SPEC_PROFILE_AI_ACTIVITY_HUB^MDC | 1 | |
| Fall sensor | CWE | 8519681^MDC_AI_TYPE_SENSOR_FALL^MDC | 1.0.0.1 | One of the following flags…<br><0 or 1>^fall-detected(0)<br>Additionally, optionally, any of the general sensor health flags…<br><0 or 1>^auto-presence-received(16),<br><0 or 1>^auto-presence-failed(17),<br><0 or 1>^low-battery(18),<br><0 or 1>^fault(19),<br><0 or 1>^end-of-life(20) |

**Table E.29 – Independent living activity hub encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| Location (Fall sensor) | CWE | 8520703^MDC_AI_LOCATION^MDC or 68193^MDC_ATTR_SUPPLEMENTAL_TYPES^MDC | 1.0.0.1.1 | Any of the 10471 location codes that are specified in the Supplemental-Types.<br>For example:<br>8523328^MDC_AI_LOCATION_LIVINGROOM^MDC |
| PERS sensor | CWE | 8519682^MDC_AI_TYPE_SENSOR_PERS^MDC | 1.0.0.2 | One of the following flags…<br><0 or 1>^pers-activated(0)<br>Additionally, optionally, any of the general sensor health flags…<br><0 or 1>^auto-presence-received(16),<br><0 or 1>^auto-presence-failed(17),<br><0 or 1>^low-battery(18),<br><0 or 1>^fault(19),<br><0 or 1>^end-of-life(20) |
| Location (PERS sensor) | CWE | 8520703^MDC_AI_LOCATION^MDC or 68193^MDC_ATTR_SUPPLEMENTAL_TYPES^MDC | 1.0.0.2.1 | Any of the 10471 location codes that are specified in the Supplemental-Types.<br>For example:<br>8523328^MDC_AI_LOCATION_LIVINGROOM^MDC |
| Environmental sensor - smoke | CWE | 8519683^MDC_AI_TYPE_SENSOR_SMOKE^MDC | 1.0.0.3 | One of the following flags…<br><0 or 1>^condition-detected(0)<br>Additionally, optionally, any of the general sensor health flags…<br><0 or 1>^auto-presence-received(16),<br><0 or 1>^auto-presence-failed(17),<br><0 or 1>^low-battery(18),<br><0 or 1>^fault(19),<br><0 or 1>^end-of-life(20) |

**Table E.29 – Independent living activity hub encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| Location (Environmental sensor - smoke) | CWE | 8520703^MDC_AI_LOCATION^MDC or 68193^MDC_ATTR_SUPPLEMENTAL_TYPES^ MDC | 1.0.0.3.1 | Any of the 10471 location codes that are specified in the Supplemental-Types.<br>For example:<br>8523328^MDC_AI_LOCATION_LIVINGROO M^MDC |
| Environmental sensor - CO | CWE | 8519684^MDC_AI_TYPE_SENSOR_CO^MDC | 1.0.0.4 | One of the following flags…<br><0 or 1>^condition-detected(0)<br>Additionally, optionally, any of the general sensor health flags…<br><0 or 1>^auto-presence-received(16),<br><0 or 1>^auto-presence-failed(17),<br><0 or 1>^low-battery(18),<br><0 or 1>^fault(19),<br><0 or 1>^end-of-life(20) |
| Location (Environmental sensor - CO) | CWE | 8520703^MDC_AI_LOCATION^MDC or 68193^MDC_ATTR_SUPPLEMENTAL_TYPES^ MDC | 1.0.0.4.1 | Any of the 10471 location codes that are specified in the Supplemental-Types.<br>For example:<br>8523328^MDC_AI_LOCATION_LIVINGROO M^MDC |
| Environmental sensor - water | CWE | 88519685^MDC_AI_TYPE_SENSOR_WATER^ MDC | 1.0.0.5 | One of the following flags…<br><0 or 1>^condition-detected(0)<br>Additionally, optionally, any of the general sensor health flags…<br><0 or 1>^auto-presence-received(16),<br><0 or 1>^auto-presence-failed(17),<br><0 or 1>^low-battery(18),<br><0 or 1>^fault(19),<br><0 or 1>^end-of-life(20) |

**Table E.29 – Independent living activity hub encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| Location (Environmental sensor - water) | CWE | 8520703^MDC_AI_LOCATION^MDC or 68193^MDC_ATTR_SUPPLEMENTAL_TYPES^MDC | 1.0.0.5.1 | Any of the 10471 location codes that are specified in the Supplemental-Types.<br>For example:<br>8523328^MDC_AI_LOCATION_LIVINGROOM^MDC |
| Environmental sensor - gas | CWE | 8519686^MDC_AI_TYPE_SENSOR_GAS^MDC | 1.0.0.6 | <0 or 1>^condition-detected(0)<br>Additionally, optionally, any of the general sensor health flags…<br><0 or 1>^auto-presence-received(16),<br><0 or 1>^auto-presence-failed(17),<br><0 or 1>^low-battery(18),<br><0 or 1>^fault(19),<br><0 or 1>^end-of-life(20) |
| Location (Environmental sensor - gas) | CWE | 8520703^MDC_AI_LOCATION^MDC or 68193^MDC_ATTR_SUPPLEMENTAL_TYPES^MDC | 1.0.0.6.1 | Any of the 10471 location codes that are specified in the Supplemental-Types.<br>For example:<br>8523328^MDC_AI_LOCATION_LIVINGROOM^MDC |
| Motion sensor | CWE | 8519687^MDC_AI_TYPE_SENSOR_MOTION^MDC | 1.0.0.7 | One of the following flags…<br><0 or 1>^motion-detected(0),<br><0 or 1>^motion-detected-delayed(1),<br><0 or 1>^tamper-detected(2)<br>Additionally, optionally, any of the general sensor health flags…<br><0 or 1>^auto-presence-received(16),<br><0 or 1>^auto-presence-failed(17),<br><0 or 1>^low-battery(18),<br><0 or 1>^fault(19), |

### Table E.29 – Independent living activity hub encoding – Part 1

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| | | | | <0 or 1>^end-of-life(20) |
| Location (Motion sensor) | CWE | 8520703^MDC_AI_LOCATION^MDC or 68193^MDC_ATTR_SUPPLEMENTAL_TYPES^MDC | 1.0.0.7.1 | Any of the 10471 location codes that are specified in the Supplemental-Types.<br>For example:<br>8523328^MDC_AI_LOCATION_LIVINGROOM^MDC |
| Property exit sensor | CWE | 8519688^MDC_AI_TYPE_SENSOR_PROPEXIT^MDC | 1.0.0.8 | One of the following flags…<br><0 or 1>^occupant-exit-property(0),<br><0 or 1>^exit-door-left-open(1)<br>Additionally, optionally, any of the general sensor health flags…<br><0 or 1>^auto-presence-received(16),<br><0 or 1>^auto-presence-failed(17),<br><0 or 1>^low-battery(18),<br><0 or 1>^fault(19),<br><0 or 1>^end-of-life(20) |
| Location (Exit sensor) | CWE | 8520703^MDC_AI_LOCATION^MDC or 68193^MDC_ATTR_SUPPLEMENTAL_TYPES^MDC | 1.0.0.8.1 | Any of the 10471 location codes that are specified in the Supplemental-Types.<br>For example:<br>8523328^MDC_AI_LOCATION_LIVINGROOM^MDC |
| Enuresis sensor | CWE | 8519689^MDC_AI_TYPE_SENSOR_ENURESIS^MDC | 1.0.0.9 | One of the following flags…<br><0 or 1>^enuresis-detected(0)<br>Additionally, optionally, any of the general sensor health flags…<br><0 or 1>^auto-presence-received(16),<br><0 or 1>^auto-presence-failed(17),<br><0 or 1>^low-battery(18), |

**Table E.29 – Independent living activity hub encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| | | | | <0 or 1>^fault(19),<br><0 or 1>^end-of-life(20) |
| Location (Enuresis sensor) | CWE | 8520703^MDC_AI_LOCATION^MDC or 68193^MDC_ATTR_SUPPLEMENTAL_TYPES^MDC | 1.0.0.9.1 | Any of the 10471 location codes that are specified in the Supplemental-Types.<br>For example:<br>8523328^MDC_AI_LOCATION_LIVINGROOM^MDC |
| Contact closure sensor | CWE | 8519690^MDC_AI_TYPE_SENSOR_CONTACTCLOSURE^MDC | 1.0.0.10 | One of the following flags…<br><0 or 1>^contact-opened(0),<br><0 or 1>^contact-closed(1)<br>Additionally, optionally, any of the general sensor health flags…<br><0 or 1>^auto-presence-received(16),<br><0 or 1>^auto-presence-failed(17),<br><0 or 1>^low-battery(18),<br><0 or 1>^fault(19),<br><0 or 1>^end-of-life(20) |
| Location (Contact closure sensor) | CWE | 8520703^MDC_AI_LOCATION^MDC or 68193^MDC_ATTR_SUPPLEMENTAL_TYPES^MDC | 1.0.0.10.1 | Any of the 10471 location codes that are specified in the Supplemental-Types.<br>For example:<br>8523328^MDC_AI_LOCATION_LIVINGROOM^MDC |
| Usage sensor | CWE | 8519691^MDC_AI_TYPE_SENSOR_USAGE^MDC | 1.0.0.11 | One of the following flags…<br><0 or 1>^usage-started(0),<br><0 or 1>^usage-ended(1),<br><0 or 1>^expected-use-start-violation(2),<br><0 or 1>^expected-use-stop-violation(3),<br><0 or 1>^absence-violation(4) |

Table E.29 – Independent living activity hub encoding – Part 1

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| | | | | Additionally, optionally, any of the general sensor health flags…<br><0 or 1>^auto-presence-received(16),<br><0 or 1>^auto-presence-failed(17),<br><0 or 1>^low-battery(18),<br><0 or 1>^fault(19),<br><0 or 1>^end-of-life(20) |
| Location (Usage sensor) | CWE | 8520703^MDC_AI_LOCATION^MDC or 68193^MDC_ATTR_SUPPLEMENTAL_TYPES^MDC | 1.0.0.11.1 | Any of the 10471 location codes that are specified in the Supplemental-Types.<br>For example:<br>8523328^MDC_AI_LOCATION_LIVINGROOM^MDC |
| Switch sensor | CWE | 8519692^MDC_AI_TYPE_SENSOR_SWITCH^MDC | 1.0.0.12 | One of the following flags…<br><0 or 1>^switch-on(0),<br><0 or 1>^switch-off(1)<br>Additionally, optionally, any of the general sensor health flags…<br><0 or 1>^auto-presence-received(16),<br><0 or 1>^auto-presence-failed(17),<br><0 or 1>^low-battery(18),<br><0 or 1>^fault(19),<br><0 or 1>^end-of-life(20) |
| Location (Switch sensor) | CWE | 8520703^MDC_AI_LOCATION^MDC or 68193^MDC_ATTR_SUPPLEMENTAL_TYPES^MDC | 1.0.0.12.1 | Any of the 10471 location codes that are specified in the Supplemental-Types.<br>For example:<br>8523328^MDC_AI_LOCATION_LIVINGROOM^MDC |

## Table E.29 – Independent living activity hub encoding – Part 1

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| Medication dosage sensor | CWE | 8519693^MDC_AI_TYPE_SENSOR_DOSAGE^MDC | 1.0.0.13 | One of the following flags…<br><0 or 1>^dosage-taken(0),<br><0 or 1>^dosage-missed(1)<br>Additionally, optionally, any of the general sensor health flags…<br><0 or 1>^auto-presence-received(16),<br><0 or 1>^auto-presence-failed(17),<br><0 or 1>^low-battery(18),<br><0 or 1>^fault(19),<br><0 or 1>^end-of-life(20) |
| Location (Dosage sensor) | CWE | 8520703^MDC_AI_LOCATION^MDC or 68193^MDC_ATTR_SUPPLEMENTAL_TYPES^MDC | 1.0.0.13.1 | Any of the 10471 location codes that are specified in the Supplemental-Types.<br>For example:<br>8523328^MDC_AI_LOCATION_LIVINGROOM^MDC |
| Temperature sensor | CWE | 8519694^MDC_AI_TYPE_SENSOR_TEMP^MDC | 1.0.0.14 | One of the following flags…<br><0 or 1>^high-temperature-detected(0),<br><0 or 1>^low-temperature-detected(1),<br><0 or 1>^rate-of-change-too-fast(2)<br>Additionally, optionally, any of the general sensor health flags…<br><0 or 1>^auto-presence-received(16),<br><0 or 1>^auto-presence-failed(17),<br><0 or 1>^low-battery(18),<br><0 or 1>^fault(19),<br><0 or 1>^end-of-life(20) |

**Table E.29 – Independent living activity hub encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| Location (Temperature sensor) | CWE | 8520703^MDC_AI_LOCATION^MDC or 68193^MDC_ATTR_SUPPLEMENTAL_TYPES^MDC | 1.0.0.14.1 | Any of the 10471 location codes that are specified in the Supplemental-Types.<br>For example:<br>8523328^MDC_AI_LOCATION_LIVINGROOM^MDC |

**Table E.30 – Independent living activity hub encoding – Part 2**

| Description | OBX-6 | OBX-18 | OBX-20 |
|---|---|---|---|
| Independent living activity hub MDS | | 0123456789ABCDEF^^0123456789ABCDEF^EUI-64 | |
| Fall sensor | | | |
| Location (Fall sensor) | | | |
| PERS sensor | | | |
| Location (PERS sensor) | | | |
| Environmental sensor - smoke) | | | |
| Location (Environmental sensor - smoke) | | | |
| Environmental sensor - CO | | | |
| Location (Environmental sensor - CO) | | | |
| Environmental sensor - water | | | |
| Location (Environmental sensor - water) | | | |
| Environmental sensor - gas | | | |
| Location (Environmental sensor - gas) | | | |
| Motion sensor | | | |
| Location (Motion sensor) | | | |

**Table E.30 – Independent living activity hub encoding – Part 2**

| Description | OBX-6 | OBX-18 | OBX-20 |
|---|---|---|---|
| Property Exit sensor | | | |
| Location (Exit sensor) | | | |
| Enuresis sensor | | | |
| Location (Enuresis sensor) | | | |
| Contact closure sensor | | | |
| Location (Contact closure sensor) | | | |
| Usage sensor | | | |
| Location (Usage sensor) | | | |
| Switch sensor | | | |
| Location (Switch sensor) | | | |
| Medication dosage sensor | | | |
| Location (Dosage sensor) | | | |
| Temperature sensor | | | |
| Location (Temperature sensor) | | | |

### E.3.10 10472 Adherence monitor

#### E.3.10.1 Modelling

All attributes are metrics of the Adherence monitor object. Note that the feedback object has a compound attribute and its containment OBX is placed on the channel n-tuple.

#### E.3.10.2 Transformations

The following transformations are performed in the encoding of this device.

A nomenclature code has been harmonized with the underlying base code. This is pointed out in the tables below.

### E.3.10.3 Containment tree

Table E.31 shows an adherence monitor containment tree.

**Table E.31 – Adherence monitor containment tree**

| REFID | Description |
|---|---|
| MDC_DEV_SPEC_PROFILE_AI_MED_MINDER | Adherence monitor MDS |
| ... MDC_AI_MED_DISPENSED_FIXED | Fixed dosage dispensed |
| ... MDC_AI_MED_DISPENSED_VARIABLE | Variable dosage dispensed |
| .. MDC_AI_MED_FEEDBACK | User feedback channel |
| ... MDC_AI_MED_UF_LOCATION | User feedback location |
| ... MDC_AI_MED_UF_RESPONSE | User feedback response |
| ... MDC_AI_MED_STATUS | Status reporter |
| ... MDC_ATTR_CONTEXT_KEY | Context key |

### E.3.10.4 OBX encoding

Table E.32 and Table E.33 show part 1 and part 2 (respectively) of an adherence monitor encoding

**Table E.32 – Adherence monitor encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| Adherence monitor MDS | | 528456^MDC_DEV_SPEC_PROFILE_AI_MED_MINDER^MDC | 1 | |
| Fixed dosage dispensed | NM | 8532992^MDC_AI_MED_DISPENSED_FIXED^MDC | 1.0.0.1 | 44 |
| Variable dosage dispensed | NM | 8532993^MDC_AI_MED_DISPENSED_VARIABLE^MDC | 1.0.0.2 | 1.5 |
| User feedback channel | NA | 8532995^MDC_AI_MED_FEEDBACK^MDC | 1.0.1 | 5^3 |
| User feedback location | NM | 8532996^MDC_AI_MED_UF_LOCATION^MDC | 1.0.1.1 | 5 |

## Table E.32 – Adherence monitor encoding – Part 1

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| User feedback response | NM | 8532997^MDC_AI_MED_UF_RESPONSE^MDC | 1.0.1.2 | 3 |
| Status reporter | CWE | 8532994^MDC_AI_MED_STATUS^MDC | 1.0.0.3 | Any of the status flags…..<br><0 or 1>^medication-not-dispensed-as-expected(0)<br><0 or 1>^medication-dispensed-unexpectedly(1)<br><0 or 1>^medication-unfit(2)<br><0 or 1>^medication-expiration(3)<br><0 or 1>^medication-course-complete(4)<br><0 or 1>^medication-taken-incorrectly(5)<br><0 or 1>^medication-course-reloaded(6)<br><0 or 1>^monitor-tamper(7)<br><0 or 1>^monitor-environmental-exceeded-high(8)<br><0 or 1>^monitor-environmental-exceeded-low(9)<br><0 or 1>^monitor-inoperable(10)<br><0 or 1>^consumer-non-compliant-yellow(11)<br><0 or 1>^consumer-non-compliant-red(12) |
| Context key | EI | 68216^MDC_ATTR_CONTEXT_KEY^MDC | 1.0.0.4 | 0123456789ABCDEF^^0123456789ABCDEF^EUI-64 |

## Table E.33 – Adherence monitor encoding – Part 2

| Description | OBX-6 | OBX-18 | OBX-20 |
|---|---|---|---|
| Adherence monitor MDS | | 0123456789ABCDEF^^0123456789ABCDEF^EUI-64 | |
| Fixed dosage dispensed | Leave blank or 262656^MDC_DIM_DIMLESS^MDC | | |
| Variable dosage dispensed | 236762^MDC_DIM_MILLI_L^MDC or<br>263890^MDC_DIM_MILLI_G^MDC or<br>267616^MDC_DIM_INTL_UNIT^MDC | | |

**Table E.33 – Adherence monitor encoding – Part 2**

| Description | OBX-6 | OBX-18 | OBX-20 |
|---|---|---|---|
| | NOTE – The underlying standard uses MDC_DIM_X_INTL_UNIT but this is translated to MDC_DIM_INTL_UNIT for the Services interface | | |
| User feedback channel | Leave blank or 262656^MDC_DIM_DIMLESS^MDC | | |
| User feedback location | Leave blank or 262656^MDC_DIM_DIMLESS^MDC | | |
| User feedback response | Leave blank or 262656^MDC_DIM_DIMLESS^MDC | | |
| Status reporter | | | |

### E.3.11 10421 Peak expiratory flow monitor

NOTE – Specialization not final at time of authoring.

#### E.3.11.1 Modelling

All attributes are metrics of the peak expiratory flow monitor object.

#### E.3.11.2 Transformations

The following transformations are performed in the encoding of this device.

A nomenclature code has been harmonized with the underlying base code. This is pointed out in the tables below.

#### E.3.11.3 Containment tree

Table E.34 shows a peak expiratory flow containment tree.

**Table E.34 – Peak expiratory flow containment tree**

| REFID | Description |
|---|---|
| MDC_DEV_SPEC_PROFILE_PEFM | Peak expiratory flow MDS |
| ... MDC_FLOW_AWAY_EXP_FORCED_PEAK | PEF |
| .... MDC_ATTR_MSMT_STAT | Measurement status (PEF) |
| ... MDC_FLOW_AWAY_EXP_FORCED_PEAK_PB | Personal best |
| ... MDC_FLOW_AWAY_EXP_FORCED_PEAK_1S | FEV1 |
| .... MDC_ATTR_MSMT_STAT | Measurement status (FEV1) |
| ... MDC_FLOW_AWAY_EXP_FORCED_PEAK_6S | FEV6 |
| .... MDC_ATTR_MSMT_STAT | Measurement status (FEV6) |

### E.3.11.4 OBX encoding

Table E.35 and Table E.36 show part 1 and part 2 (respectively) of a peak expiratory flow monitor encoding.

**Table E.35 – Peak expiratory flow monitor encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| Peak expiratory flow MDS | | 528405^MDC_DEV_SPEC_PROFILE_PEFM^MDC | 1 | |
| PEF | NM | 152584^MDC_FLOW_AWAY_EXP_FORCED_ PEAK^MDC | 1.0.0.1 | 67.3 |
| Measurement status (PEF) | CWE | 67911^MDC_ATTR_MSMT_STAT^MDC | 1.0.0.1.1 | Any of the following flags…<br><0 or 1>^msmt-stat-post-med(0) or<br><0 or 1>^msmt-stat-cough(1) or<br><0 or 1>^msmt-stat-short-effort(2) or<br><0 or 1>^msmt-stat-long-time-to-peak(3) |
| Personal best | NM | 152585^MDC_FLOW_AWAY_EXP_FORCED_ PEAK_PB^MDC | 1.0.0.2 | 33.5 |
| FEV1 | NM | 152586^MDC_FLOW_AWAY_EXP_FORCED_ PEAK_1S^MDC | 1.0.0.3 | 44.5 |

**Table E.35 – Peak expiratory flow monitor encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| Measurement status (FEV1) | CWE | 67911^MDC_ATTR_MSMT_STAT^MDC | 1.0.0.3.1 | Any of the following flags…<br><0 or 1>^msmt-stat-post-med(0) or<br><0 or 1>^msmt-stat-cough(1) or<br><0 or 1>^msmt-stat-short-effort(2) or<br><0 or 1>^msmt-stat-long-time-to-peak(3) |
| FEV6 | NM | 152587^MDC_FLOW_AWAY_EXP_FORCED_ PEAK_6S^MDC | 1.0.0.4 | 55.6 |
| Measurement status (FEV6) | CWE | 67911^MDC_ATTR_MSMT_STAT^MDC | 1.0.0.4.1 | Any of the following flags…<br><0 or 1>^msmt-stat-post-med(0) or<br><0 or 1>^msmt-stat-cough(1) or<br><0 or 1>^msmt-stat-short-effort(2) or<br><0 or 1>^msmt-stat-long-time-to-peak(3) |

**Table E.36 – Peak expiratory flow monitor encoding – Part 2**

| Description | OBX-6 | OBX-18 | OBX-20 |
|---|---|---|---|
| Peak expiratory flow MDS | | 0123456789ABCDEF^^0123456789ABCDEF^EUI-64 | |
| PEF | 264992^MDC_DIM_L_PER_MIN^MDC<br>NOTE – The underlying standard uses MDC_DIM_X_L_PER_MIN but this is translated to MDC_DIM_L_PER_MIN for the Services interface. | | |
| Measurement status (PEF) | | | |
| Personal best | 264992^MDC_DIM_L_PER_MIN^MDC<br>NOTE – The underlying standard uses MDC_DIM_X_L_PER_MIN but this is translated | | |

**Table E.36 – Peak expiratory flow monitor encoding – Part 2**

| Description | OBX-6 | OBX-18 | OBX-20 |
|---|---|---|---|
| | to MDC_DIM_L_PER_MIN for the Services interface. | | |
| FEV1 | 263744^MDC_DIM_L^MDC<br>NOTE – The underlying standard uses MDC_DIM_X_L but this is translated to MDC_DIM_L for the Services interface | | |
| Measurement status (FEV1) | | | |
| FEV6 | 263744^MDC_DIM_L^MDC<br>NOTE – The underlying standard uses MDC_DIM_X_L but this is translated to MDC_DIM_L for the Services interface | | |
| Measurement status (FEV6) | | | |

### E.3.12 10420 Body composition analyser

#### E.3.12.1 Modelling

This is modelled with the measurements as individual METRIC level observations.

#### E.3.12.2 Transformations

The following transformations are performed in the encoding of this device.

#### E.3.12.3 Containment tree

Table E.37 shows a body composition analyser containment tree.

**Table E.37 – Body composition analyser containment tree**

| REFID | Description |
|---|---|
| MDC_DEV_SPEC_PROFILE_BCA | Body composition analyzer MDS |
| ... MDC_BODY_FAT | Body fat |
| ... MDC_LEN_BODY_ACTUAL | Body height |
| ... MDC_MASS_BODY_ACTUAL | Body weight |
| ... MDC_RATIO_MASS_BODY_LEN_SQ | Body Mass Index |
| ....MDC_SOURCE_HANDLE_REF | Source-Handle-Reference<br>Reference to the corresponding body weight |
| ... MDC_MASS_BODY_FAT_FREE | Fat free mass |
| ... MDC_MASS_BODY_SOFT_LEAN | Soft lean mass |
| ... MDC_BODY_WATER | Body water |

### E.3.12.4 OBX encoding

Table E.38 and Table E.39 show part 1 and part 2 (respectively) of a body composition analyser OBX encoding.

**Table E.38 – Body composition analyser OBX encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| Body composition analyser MDS | | 528404^MDC_DEV_SPEC_PROFILE_BCA^MDC | 1 | |
| Body fat | NM | 188748^MDC_BODY_FAT^MDC | 1.0.0.1 | 28.3 |
| Body height | NM | 188740^MDC_LEN_BODY_ACTUAL^MDC | 1.0.0.2 | 175 |
| Body weight | NM | 188736^MDC_MASS_BODY_ACTUAL^MDC | 1.0.0.3 | 73.5 |
| Body Mass Index | NM | 188752^MDC_RATIO_MASS_BODY_LEN_SQ^MDC | 1.0.0.4 | 24.0 |
| Source-Handle-Reference | ST | 68167^MDC_ATTR_SOURCE_HANDLE_REF^MDC | 1.0.0.4.1 | 1.0.0.3 |
| Fat free mass | NM | 188756^MDC_MASS_BODY_FAT_FREE^MDC | 1.0.0.5 | 52.6 |
| Soft lean mass | NM | 188760^MDC_MASS_BODY_SOFT_LEAN^MDC | 1.0.0.6 | 49.1 |
| Body water | NM | 188764^MDC_BODY_WATER^MDC | 1.0.0.7 | 38.5 |

**Table E.39 – Body composition analyser OBX encoding – Part 2**

| Description | OBX-6 | OBX-18 | OBX-20 |
|---|---|---|---|
| Body composition analyzer MDS | | 0123456789ABCDEF^^0123456789ABCDEF^ EUI-64 | |
| Body fat | 262688^MDC_DIM_PERCENT^MDC or 263875^MDC_DIM_KILO_G^MDC or 263904^MDC_DIM_LB^MDC | | |
| Body height | 263441^MDC_DIM_CENTI_M^MDC or 263520^MDC_DIM_INCH^MDC | | |
| Body weight | 263875^MDC_DIM_KILO_G^MDC or 263904^MDC_DIM_LB^MDC | | |
| Body Mass Index | 264096^MDC_DIM_KG_PER_M_SQ^MDC | | |
| Source-Handle-Reference | | | |
| Fat free mass | 263875^MDC_DIM_KILO_G^MDC or 263904^MDC_DIM_LB^MDC | | |
| Soft lean ass | 263875^MDC_DIM_KILO_G^MDC or 263904^MDC_DIM_LB^MDC | | |
| Body water | 263875^MDC_DIM_KILO_G^MDC or 263904^MDC_DIM_LB^MDC or 262688^MDC_DIM_PERCENT^MDC | | |

### E.3.13 IEEE 10406 basic 1-3 lead ECG

#### E.3.13.1 Modelling

This is modelled with the measurements as individual METRIC level observations.

#### E.3.13.2 Transformations

The following transformations are performed in the encoding of this device.

### E.3.13.3 Containment tree

Table E.40 shows a basic 1-3 lead ECG containment tree.

**Table E.40 – Basic 1-3 lead ECG containment tree**

| REFID | Description |
|---|---|
| MDC_DEV_SPEC_PROFILE_ECG | Basic 1-3 Lead ECG MDS |
| ... MDC_ATTR_SYS_TYPE_SPEC_LIST | System-Type-Spec-List, contains profile identifier for Simple ECG and heart rate monitor |
| ... MDC_ATTR_TICK_RES | Tick resolution |
| ... MDC_ECG_HEART_RATE or^<br>... MDC_ECG_HEART_RATE_ISNTANT | Heart rate |
| ... MDC_ECG_TIME_PD_RR_GL | R-R interval |
| ... MDC_ECG_ELEC_POTL or^<br>... MDC_ECG_ELEC_POTL_I or^<br>... MDC_ECG_ELEC_POTL_II or^<br>... MDC_ECG_ELEC_POTL_III or^<br>... MDC_ECG_ELEC_POTL_AVR or^<br>... MDC_ECG_ELEC_POTL_AVL or^<br>... MDC_ECG_ELEC_POTL_AVF or^<br>... MDC_ECG_ELEC_POTL_V1 or^<br>... MDC_ECG_ELEC_POTL_V2 or^<br>... MDC_ECG_ELEC_POTL_V3 or^<br>... MDC_ECG_ELEC_POTL_V4 or^<br>... MDC_ECG_ELEC_POTL_V5 or^<br>... MDC_ECG_ELEC_POTL_V6 | ECG waveform |
| .... MDC_ATTR_TIME_PD_SAMP | ECG waveform sample period |
| ... MDC_ECG_DEV_STAT | Device status |
| ... MDC_ECG_EVT_CTXT_GEN | Context data trigger |

### E.3.13.4 OBX encoding

Table E.41 and Table E.42 show part 1 and part 2 (respectively) of a basic 1-3 lead ECG OBX encoding.

**Table E.41 – Basic 1-3 lead ECG OBX encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| Basic 1-3 Lead ECG MDS | | 528384^MDC_DEV_SPEC_PROFILE_HYDRA^MDC | 1 | |
| System-Type-Spec-List | CWE | 68186^MDC_ATTR_SYS_TYPE_SPEC_LIST^MDC | 1.0.0.1 | 528390^MDC_DEV_SPEC_PROFILE_ECG^MDC<br>and at least one of the following two profile values:<br>528524^MDC_DEV_SUB_SPEC_PROFILE_ECG^MDC<br>528525^MDC_DEV_SUB_SPEC_PROFILE_HR^MDC |
| Tick-Resolution | NM | 68229^MDC_ATTR_TICK_RES^MDC | 1.0.0.2 | 1024 |
| Heart rate | NM | 147842^MDC_ECG_HEART_RATE^MDC or<br>8410590^MDC_ECG_HEART_RATE_INSTANT^MDC | 1.0.0.3 | 80 |
| R-R interval | NM | 147240^MDC_ECG_TIME_PD_RR_GL^MDC | 1.0.0.4 | 768 |
| ECG waveform | NA | 131328^MDC_ECG_ELEC_POTL^MDC or<br>131329^MDC_ECG_ELEC_POTL_I^MDC or<br>131330^MDC_ECG_ELEC_POTL_II^MDC or<br>131389^MDC_ECG_ELEC_POTL_III^MDC or<br>131390^MDC_ECG_ELEC_POTL_AVR^MDC or<br>131391^MDC_ECG_ELEC_POTL_AVL^MDC or<br>131392^MDC_ECG_ELEC_POTL_AVF^MDC or<br>131331^MDC_ECG_ELEC_POTL_V1^MDC or<br>131332^MDC_ECG_ELEC_POTL_V2^MDC or<br>131333^MDC_ECG_ELEC_POTL_V3^MDC or<br>131334^MDC_ECG_ELEC_POTL_V4^MDC or<br>131335^MDC_ECG_ELEC_POTL_V5^MDC or<br>131336^MDC_ECG_ELEC_POTL_V6^MDC | 1.0.0.5 | 11^22^33^44^55^23^33^46^9^…<br>NOTE that the actual values of the waveform may need to be computed based on the scaling values in the Scale-And-Range-Specification object |
| ECG waveform Sample-Period | NM | 67981^MDC_ATTR_TIME_PD_SAMP^MDC | 1.0.0.5.1 | 250 |

**Table E.41 – Basic 1-3 lead ECG OBX encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| Device status | CWE | 8410584^MDC_ECG_DEV_STAT^MDC | 1.0.0.6 | One of the values…<br><0 or 1>^leadwire-loss(0),<br><0 or 1>^leadsignal-loss(1),<br><0 or 1>^leadwire-loss-first-lead(2),<br><0 or 1>^leadsignal-loss-first-lead(3),<br><0 or 1>^leadwire-loss-second-lead(4),<br><0 or 1>^leadsignal-loss-second-lead(5),<br><0 or 1>^leadwire-loss-third-lead(6),<br><0 or 1>^leadsignal-loss-third-lead(7) |
| Context data trigger | CWE | 8410585^MDC_ECG_EVT_CTXT_GEN^MDC | 1.0.0.7 | 8410586^MDC_ECG_EVT_CTXT_USER^MDC or<br>8410587^MDC_ECG_EVT_CTXT_PERIODIC^MDC or<br>8410588^MDC_ECG_EVT_CTXT_DETECTED^MDC or<br>8410589^MDC_ECG_EVT_CTXT_EXTERNAL^MDC |

**Table E.42 – Basic 1-3 lead ECG OBX encoding – Part 2**

| Description | OBX-6 | OBX-18 | OBX-20 |
|---|---|---|---|
| Basic 1-3 Lead ECG MDS | | 0123456789ABCDEF^^0123456789ABCDEF^EUI-64 | |
| System-Type-Spec-List | | | |
| Tick-Resolution | 265842^MDC_DIM_PER_SEC^MDC | | |
| Heart rate | 264864^MDC_DIM_BEAT_PER_MIN^MDC | | |
| R-R interval | 264338^MDC_DIM_MILLI_SEC^MDC or 268992^MDC_DIM_TICK^MDC | | |
| ECG waveform | 266418^MDC_DIM_MILLI_VOLT^MDC | | |
| ECG waveform Sample-Period | 264339^MDC_DIM_MICRO_SEC^MDC | | |
| Device status | | | |
| Context data trigger | | | |

### E.3.14 10424 Sleep apnoea breathing therapy equipment (SABTE)

#### E.3.14.1 Modelling

This is modelled with the measurements as individual METRIC level observations.

#### E.3.14.2 Transformations

The following transformations are performed in the encoding of this device.

#### E.3.14.3 Containment tree

Table E.43 shows a sleep apnoea breathing therapy equipment (SABTE) containment tree.

**Table E.43 – Sleep apnoea breathing therapy equipment (SABTE) containment tree**

| REFID | Description |
|---|---|
| MDC_DEV_SPEC_PROFILE_SABTE | Sleep apnoea breathing therapy eEquipment (SABTE) MDS |
| ... MDC_PHD_DM_DEV_STAT | PHD DM device status |
| ... MDC_SABTE_TIME_PD_FLOW_GEN_TOTAL | Duration of flow generation |
| ... MDC_SABTE_TIME_PD_USAGE_TOTAL or<br>... MDC_SABTE_TIME_PD_USAGE_W_HUM or<br>... MDC_SABTE_TIME_PD_USAGE_WO_HUM | Duration of patient use |
| ... MDC_SABTE_TIME_PD_SNORING_TOTAL | Snoring duration |
| ... MDC_SABTE_TIME_PD_CSR_TOTAL | Cheyne-Stokes respiration (CSR) duration |
| ... MDC_SABTE_TIME_PD_RAMP_SET | Ramp duration setting |
| ... MDC_SABTE_FLOW_TOTAL or<br>... MDC_SABTE_FLOW_WO_PURGE or<br>... MDC_SABTE_FLOW_RESP | Airflow waveform |
| .... MDC_ATTR_TIME_PD_SAMP | Airflow waveform sample period |
| .. MDC_SABTE_AHI | Apnoea-Hypopnoea-Index (AHI) compound of uAHI, oAHI and cAHI |
| ... MDC_SABTE_AHI_UNCLASS | uAHI |
| ... MDC_SABTE_AHI_OBSTRUC | oAHI |
| ... MDC_SABTE_AHI_CENT | cAHI |
| ... MDC_SABTE_AHI_TOTAL or<br>... MDC_SABTE_AHI_UNCLASS or<br>... MDC_SABTE_AHI_OBSTRUC or<br>... MDC_SABTE_AHI_CENT | Apnoea-Hypopnoea-Index (AHI) |
| ... MDC_SABTE_LVL_HUMID_STAGE_SET or<br>... MDC_SABTE_LVL_HUMID_TEMP_SET or<br>... MDC_SABTE_LVL_HUMID_HUM_SET | Humidifier level setting |
| ... MDC_SABTE_LVL_TRIG_SENS_SET | Trigger sensitivity setting |
| ... MDC_SABTE_LVL_INSP_PRESS_RISE_SET | Inspiration pressure rise setting |

**Table E.43 – Sleep apnoea breathing therapy equipment (SABTE) containment tree**

| REFID | Description |
|---|---|
| ... MDC_SABTE_LVL_ADAPT_SET | Pressure adaption level setting |
| ... MDC_SABTE_MODE_ADAPT_FREEZE_SET | Pressure adaption freeze setting |
| ... MDC_SABTE_MODE_AUTOSTARTSTOP_SET | Autostart/-stop setting |
| ... MDC_SABTE_MODE_DEV_SET | Device mode setting |
| ... MDC_SABTE_MODE_THERAPY_SET | Therapy mode setting |
| ... MDC_SABTE_PATT_COMPLIANCE_CLS | Compliance annotations |
| ... MDC_SABTE_PATT_EFFICACY_CLS | Efficacy annotations |
| ... MDC_SABTE_PRESS or<br>... MDC_SABTE_PRESS_TARGET | Therapy pressure waveform |
| .... MDC_ATTR_TIME_PD_SAMP | Therapy pressure waveform sample period |
| ... MDC_SABTE_PRESS_MIN or<br>... MDC_SABTE_PRESS_MAX or<br>... MDC_SABTE_PRESS_MEAN or<br>... MDC_SABTE_PRESS_P50 or<br>... MDC_SABTE_PRESS_P90 or<br>... MDC_SABTE_PRESS_P95 or<br>... MDC_SABTE_PRESS_INSTANT | Therapy pressure |
| ... MDC_SABTE_PRESS_CPAP_SET | Continuous positive airway pressure (P CPAP) setting |
| ... MDC_SABTE_PRESS_CPAP_AUTO_MIN_SET | Minimal automatic positive airway pressure (Pmin APAP) setting |
| ... MDC_SABTE_PRESS_CPAP_AUTO_MAX_SET | Maximal automatic positive airway pressure (Pmax APAP) setting |
| ... MDC_SABTE_PRESS_IPAP_SET | Inspiratory positive airway pressure (P IPAP) setting |
| ... MDC_SABTE_PRESS_EPAP_SET | Expiratory positive airway pressure (P EPAP) setting |
| ... MDC_SABTE_PRESS_RAMP_START_SET | Ramp start pressure setting |

Table E.43 – Sleep apnoea breathing therapy equipment (SABTE) containment tree

| REFID | Description |
|---|---|
| ... MDC_SABTE_RESP_RATE_MIN or<br>... MDC_SABTE_RESP_RATE_MAX or<br>... MDC_SABTE_RESP_RATE_MEAN or<br>... MDC_SABTE_RESP_RATE_P50 or<br>... MDC_SABTE_RESP_RATE_P90 or<br>... MDC_SABTE_RESP_RATE_P95 or<br>... MDC_SABTE_RESP_RATE_INSTANT | Respiratory rate |
| ... MDC_SABTE_RESP_RATE_SET | Respiratory rate setting |
| ... MDC_SABTE_RATIO_IE_MIN or<br>... MDC_SABTE_RATIO_IE_MAX or<br>... MDC_SABTE_RATIO_IE_MEAN or<br>... MDC_SABTE_RATIO_IE_P50 or<br>... MDC_SABTE_RATIO_IE_P90 or<br>... MDC_SABTE_RATIO_IE_P95 or<br>... MDC_SABTE_RATIO_IE_INSTANT | I:E ratio |
| ... MDC_SABTE_RATIO_IE_SET | I:E ratio setting |
| ... MDC_SABTE_VOL_LEAK | Leakage waveform |
| .... MDC_ATTR_TIME_PD_SAMP | Leakage waveform sample period |
| ... MDC_SABTE_VOL_LEAK_MIN or<br>... MDC_SABTE_VOL_LEAK_MAX or<br>... MDC_SABTE_VOL_LEAK_MEAN or<br>... MDC_SABTE_VOL_LEAK_P50 or<br>... MDC_SABTE_VOL_LEAK_P90 or<br>... MDC_SABTE_VOL_LEAK_P95 or<br>... MDC_SABTE_VOL_LEAK_INSTANT | Leakage |

**Table E.43 – Sleep apnoea breathing therapy equipment (SABTE) containment tree**

| REFID | Description |
|---|---|
| ... MDC_SABTE_VOL_MINUTE_MIN or<br>... MDC_SABTE_VOL_MINUTE_MAX or<br>... MDC_SABTE_VOL_MINUTE_MEAN or<br>... MDC_SABTE_VOL_MINUTE_P50 or<br>... MDC_SABTE_VOL_MINUTE_P90 or<br>... MDC_SABTE_VOL_MINUTE_P95 or<br>... MDC_SABTE_VOL_MINUTE_INSTANT | Respiratory minute volume |
| ... MDC_SABTE_VOL_TIDAL_MIN or<br>... MDC_SABTE_VOL_TIDAL_MAX or<br>... MDC_SABTE_VOL_TIDAL_MEAN or<br>... MDC_SABTE_VOL_TIDAL_P50 or<br>... MDC_SABTE_VOL_TIDAL_P90 or<br>... MDC_SABTE_VOL_TIDAL_P95 or<br>... MDC_SABTE_VOL_TIDAL_INSTANT | Tidal volume |

### E.3.14.4 OBX encoding

Table E.44 and Table E.45 show part 1 and part 2 (respectively) of a SABTE OBX encoding.

**Table E.44 – Sleep apnoea breathing therapy equipment (SABTE) OBX encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| Sleep apnoea breathing therapy equipment (SABTE) MDS | | 528409^MDC_DEV_SPEC_PROFILE_SABTE ^MDC | 1 | |
| PHD DM device status | CWE | 8408608^MDC_PHD_DM_DEV_STAT^MDC | 1.0.0.1 | One of the values…<br><0 or 1>^device-status-undetermined(0),<br><0 or 1>^device-status-reset(1),<br><0 or 1>^device-status-error(5),<br><0 or 1>^device-status-error-mechanical(6), |

**Table E.44 – Sleep apnoea breathing therapy equipment (SABTE) OBX encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| | | | | <0 or 1>^device-status-error-electronic(7),<br><0 or 1>^device-status-error-software(8),<br><0 or 1>^device-status-error-battery(9),<br><0 or 1>^device-status-service(15),<br><0 or 1>^device-status-service-time-sync-required(16),<br><0 or 1>^device-status-service-calibration-required(17),<br><0 or 1>^device-status-service-replenishment-required(18),<br><0 or 1>^device-status-battery-low(25),<br><0 or 1>^device-status-battery-depleted(26),<br><0 or 1>^device-status-battery-replaced(27),<br><0 or 1>^device-status-battery-interrupted(28) |
| Duration of flow generation | NM | 8410708^MDC_SABTE_TIME_PD_FLOW_GEN_TOTAL^MDC | 1.0.0.2 | |
| Duration of patient use | NM | 8410712^MDC_SABTE_TIME_PD_USAGE_TOTAL^MDC or 8410716^MDC_SABTE_TIME_PD_USAGE_W_HUM ^MDC or 8410720^MDC_SABTE_TIME_PD_USAGE_WO_HUM^MDC | 1.0.0.3 | |
| Snoring duration | NM | 8410724^MDC_SABTE_TIME_PD_SNORING_TOTAL^MDC | 1.0.0.4 | |
| Cheyne-Stokes respiration (CSR) duration | NM | 8410728^MDC_SABTE_TIME_PD_CSR_TOTAL^MDC | 1.0.0.5 | |
| Ramp duration setting | NM | 8410744^MDC_SABTE_TIME_PD_RAMP_SET^MDC | 1.0.0.6 | |
| Airflow waveform | NA | 8410748^MDC_SABTE_FLOW_TOTAL^MD | 1.0.0.7 | 11^22^33^44^55^66^77^88^99^…… |

**Table E.44 – Sleep apnoea breathing therapy equipment (SABTE) OBX encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| | | C or 8410752^MDC_SABTE_FLOW_WO_PURGE ^MDC or 8410756^MDC_SABTE_FLOW_RESP^MDC | | NOTE – The actual values of the waveform may need to be computed based on the scaling values in the Scale-And-Range-Specification object |
| Airflow waveform sample period | NM | 67981^MDC_ATTR_TIME_PD_SAMP^MDC | 1.0.0.7.1 | |
| Apnoea-Hypopnoea-Index (AHI) compound of uAHI, oAHI and cAHI | | 8410788^MDC_SABTE_AHI^MDC | 1.0.1.0 | |
| uAHI | NM | 8410796^MDC_SABTE_AHI_UNCLASS^MD C | 1.0.1.1 | |
| oAHI | NM | 8410800^MDC_SABTE_AHI_OBSTRUC^MD C | 1.0.1.2 | |
| cAHI | NM | 8410804^MDC_SABTE_AHI_CENT^MDC | 1.0.1.3 | |
| Apnoea-Hypopnoea-Index (AHI) | NM | 8410792^MDC_SABTE_AHI_TOTAL^MDC or 8410796^MDC_SABTE_AHI_UNCLASS^MD C or 8410800^MDC_SABTE_AHI_OBSTRUC^MD C or 8410804^MDC_SABTE_AHI_CENT^MDC | 1.0.0.8 | |
| Humidifier level setting | NM | 8410828^MDC_SABTE_LVL_HUMID_STAG E_SET^MDC or 8410832^MDC_SABTE_LVL_HUMID_TEMP _SET^MDC or 8410836^MDC_SABTE_LVL_HUMID_HUM_ SET^MDC | 1.0.0.9 | |
| Trigger sensitivity setting | NM | 8410840^MDC_SABTE_LVL_TRIG_SENS_S ET^MDC | 1.0.0.10 | |
| Inspiration pressure rise setting | NM | 8410844^MDC_SABTE_LVL_INSP_PRESS_ | 1.0.0.11 | |

**Table E.44 – Sleep apnoea breathing therapy equipment (SABTE) OBX encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| | | RISE_SET^MDC | | |
| Pressure adaption level setting | NM | 8410848^MDC_SABTE_LVL_ADAPT_SET^MDC | 1.0.0.12 | |
| Pressure adaption freeze setting | CWE | 8410868^MDC_SABTE_MODE_ADAPT_FREEZE_SET ^MDC | 1.0.0.13 | 8410869^MDC_SABTE_MODE_ADAPT_FREEZE_OFF^MDC or 8410870^MDC_SABTE_MODE_ADAPT_FREEZE_ON^MDC |
| Autostart/-stop setting | CWE | 8410872^MDC_SABTE_MODE_AUTOSTARTSTOP_SET^MDC | 1.0.0.14 | One of the values…<br><0 or 1>^sabte-autostart-on(0),<br><0 or 1>^sabte-autostop-on(1) |
| Device mode setting | CWE | 8410876^MDC_SABTE_MODE_DEV_SET^MDC | 1.0.0.15 | 8410877^MDC_SABTE_MODE_DEV_UNDETERMINED^MDC or 8410878^MDC_SABTE_MODE_DEV_STANDBY^MDC or 8410879^MDC_SABTE_MODE_DEV_THERAPY^MDC or 8410880^MDC_SABTE_MODE_DEV_MASK_FITTING^MDC or 8410881^MDC_SABTE_MODE_DEV_DRYING^MDC or 8410882^MDC_SABTE_MODE_DEV_EXPORTING^MDC |
| Therapy mode setting | CWE | 8410888^MDC_SABTE_MODE_THERAPY_SET^MDC | 1.0.0.16 | 8410889^MDC_SABTE_MODE_THERAPY_UNDETERMINED^MDC or 8410890^MDC_SABTE_MODE_THERAPY_CPAP^MDC or 8410891^MDC_SABTE_MODE_THERAPY_CPAP_AUTO^MDC or 8410892^MDC_SABTE_MODE_THERAPY_BPAP_S^MDC or 8410893^MDC_SABTE_MODE_THERAPY |

**Table E.44 – Sleep apnoea breathing therapy equipment (SABTE) OBX encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| | | | | _BPAP_T^MDC or<br>8410894^MDC_SABTE_MODE_THERAPY_BPAP_ST^MDC or<br>8410895^MDC_SABTE_MODE_THERAPY_BPAP_S_AUTO^MDC or<br>8410896^MDC_SABTE_MODE_THERAPY_BPAP_T_AUTO^MDC or<br>8410897^MDC_SABTE_MODE_THERAPY_BPAP_ST_AUTO^MDC or<br>8410898^MDC_SABTE_MODE_THERAPY_ACSV^MDC |
| Compliance annotations | CWE | 8410908^MDC_SABTE_PATT_COMPLIANCE_CLS^MDC | 1.0.0.17 | One of the values…<br><0 or 1>^sabte-annotation-epoch-undetermined-start(0),<br><0 or 1>^sabte-annotation-epoch-undetermined-stop(1),<br><0 or 1>^sabte-annotation-epoch-breathing-artifact-start(2),<br><0 or 1>^sabte-annotation-epoch-breathing-artifact-stop(3),<br><0 or 1>^sabte-annotation-epoch-breathing-spontaneous-start(4),<br><0 or 1>^sabte-annotation-epoch-breathing-spontaneous-stop(5),<br><0 or 1>^sabte-annotation-epoch-breathing-timed-start(6),<br><0 or 1>^sabte-annotation-epoch-breathing-timed-stop(7),<br><0 or 1>^sabte-annotation-epoch-snoring-start(8),<br><0 or 1>^sabte-annotation-epoch-snoring- |

**Table E.44 – Sleep apnoea breathing therapy equipment (SABTE) OBX encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| | | | | stop(9),<br><0 or 1>^sabte-annotation-epoch-csr-start(10),<br><0 or 1>^sabte-annotation-epoch-csr-stop(11),<br><0 or 1>^sabte-annotation-event-undetermined-start(12),<br><0 or 1>^sabte-annotation-event-undetermined-stop(13),<br><0 or 1>^sabte-annotation-event-flow-limitation-start(14),<br><0 or 1>^sabte-annotation-event-flow-limitation-stop(15),<br><0 or 1>^sabte-annotation-event-hypopnoea-unclassified-start(16),<br><0 or 1>^sabte-annotation-event-hypopnoea-unclassified-stop(17),<br><0 or 1>^sabte-annotation-event-hypopnoea-obstructive-start(18),<br><0 or 1>^sabte-annotation-event-hypopnoea-obstructive-stop(19),<br><0 or 1>^sabte-annotation-event-hypopnoea-central-start(20),<br><0 or 1>^sabte-annotation-event-hypopnoea-central-stop(21),<br><0 or 1>^sabte-annotation-event-apnoea-unclassified-start(22),<br><0 or 1>^sabte-annotation-event-apnoea-unclassified-stop(23),<br><0 or 1>^sabte-annotation-event-apnoea- |

**Table E.44 – Sleep apnoea breathing therapy equipment (SABTE) OBX encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| | | | | obstructive-start(24),<br><0 or 1>^sabte-annotation-event-apnoea-obstructive-stop(25),<br><0 or 1>^sabte-annotation-event-apnoea-mixed-start(26),<br><0 or 1>^sabte-annotation-event-apnoea-mixed-stop(27),<br><0 or 1>^sabte-annotation-event-apnoea-central-start(28),<br><0 or 1>^sabte-annotation-event-apnoea-central-stop(29) |
| Efficacy annotations | CWE | 8410916^MDC_SABTE_PATT_EFFICACY_CLS^MDC | 1.0.0.18 | One of the values…<br><0 or 1>^sabte-annotation-session-undetermined-start(0),<br><0 or 1>^sabte-annotation-session-undetermined-stop(1),<br><0 or 1>^sabte-annotation-session-therapy-start(2),<br><0 or 1>^sabte-annotation-session-therapy-stop(3),<br><0 or 1>^sabte-annotation-session-usage-start(4),<br><0 or 1>^sabte-annotation-session-usage-stop(5) |
| Therapy pressure waveform | NA | 8410948^MDC_SABTE_PRESS^MDC or<br>8410968^MDC_SABTE_PRESS_TARGET^MDC | 1.0.0.19 | 11^22^33^44^55^66^77^88^99^……<br>Note that the actual values of the waveform may need to be computed based on the scaling values in the Scale-And-Range-Specification object |
| Therapy pressure waveform sample | NM | 67981^MDC_ATTR_TIME_PD_SAMP^MDC | 1.0.0.19.1 | |

**Table E.44 – Sleep apnoea breathing therapy equipment (SABTE) OBX encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| period | | | | |
| Therapy pressure | NM | 8410949^MDC_SABTE_PRESS_MIN^MDC or 8410950^MDC_SABTE_PRESS_MAX^MDC or 8410951^MDC_SABTE_PRESS_MEAN^MDC or 8410955^MDC_SABTE_PRESS_P50^MDC or 8410957^MDC_SABTE_PRESS_P90^MDC or 8410958^MDC_SABTE_PRESS_P95^MDC or 8410959^MDC_SABTE_PRESS_INSTANT^MDC | 1.0.0.20 | |
| Continuous positive airway pressure (P CPAP) setting | NM | 8410972^MDC_SABTE_PRESS_CPAP_SET^MDC | 1.0.0.21 | |
| Minimal automatic positive airway pressure (Pmin APAP) setting | NM | 8410976^MDC_SABTE_PRESS_CPAP_AUTO_MIN_SET^MDC | 1.0.0.22 | |
| Maximal automatic positive airway pressure (Pmax APAP) setting | NM | 8410980^MDC_SABTE_PRESS_CPAP_AUTO_MAX_SET^MDC | 1.0.0.23 | |
| Inspiratory positive airway pressure (P IPAP) setting | NM | 8410984^MDC_SABTE_PRESS_IPAP_SET^MDC | 1.0.0.24 | |
| Expiratory positive airway pressure (P EPAP) setting | NM | 8410988^MDC_SABTE_PRESS_EPAP_SET^MDC | 1.0.0.25 | |
| Ramp start pressure setting | NM | 8411004^MDC_SABTE_PRESS_RAMP_START_SET^MDC | 1.0.0.26 | |
| Respiratory rate | NM | 8411009^MDC_SABTE_RESP_RATE_MIN^MDC or 8411010^MDC_SABTE_RESP_RATE_MAX^MDC or 8411011^MDC_SABTE_RESP_RATE_MEAN^MDC or 8411015^MDC_SABTE_RESP_RATE_P50^M | 1.0.0.27 | |

**Table E.44 – Sleep apnoea breathing therapy equipment (SABTE) OBX encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| | | DC or 8411017^MDC_SABTE_RESP_RATE_P90^MDC or 8411018^MDC_SABTE_RESP_RATE_P95^MDC or 8411019^MDC_SABTE_RESP_RATE_INSTANT^MDC | | |
| Respiratory rate setting | NM | 8411044^MDC_SABTE_RESP_RATE_SET^MDC | 1.0.0.28 | |
| I:E ratio | NM | 8411049^MDC_SABTE_RATIO_IE_MIN^MDC or 8411050^MDC_SABTE_RATIO_IE_MAX^MDC or 8411051^MDC_SABTE_RATIO_IE_MEAN^MDC or 8411055^MDC_SABTE_RATIO_IE_P50^MDC or 8411057^MDC_SABTE_RATIO_IE_P90^MDC or 8411058^MDC_SABTE_RATIO_IE_P95^MDC or 8411059^MDC_SABTE_RATIO_IE_INSTANT^MDC | 1.0.0.29 | |
| I:E ratio setting | NM | 8411084^MDC_SABTE_RATIO_IE_SET^MDC | 1.0.0.30 | |
| Leakage waveform | NA | 8411088^MDC_SABTE_VOL_LEAK^MDC | 1.0.0.31 | 11^22^33^44^55^66^77^88^99^…… Note that the actual values of the waveform may need to be computed based on the scaling values in the Scale-And-Range-Specification object |
| Leakage waveform sample period | NM | 67981^MDC_ATTR_TIME_PD_SAMP^MDC | 1.0.0.31.1 | |

**Table E.44 – Sleep apnoea breathing therapy equipment (SABTE) OBX encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| Leakage | NM | 8411089^MDC_SABTE_VOL_LEAK_MIN^MDC or 8411090^MDC_SABTE_VOL_LEAK_MAX^MDC or 8411091^MDC_SABTE_VOL_LEAK_MEAN^MDC or 8411095^MDC_SABTE_VOL_LEAK_P50^MDC or 8411097^MDC_SABTE_VOL_LEAK_P90^MDC or 8411098^MDC_SABTE_VOL_LEAK_P95^MDC or 8411099^MDC_SABTE_VOL_LEAK_INSTANT^MDC | 1.0.0.32 | |
| Respiratory minute volume | NM | 8411129^MDC_SABTE_VOL_MINUTE_MIN^MDC or 8411130^MDC_SABTE_VOL_MINUTE_MAX^MDC or 8411131^MDC_SABTE_VOL_MINUTE_MEAN^MDC or 8411135^MDC_SABTE_VOL_MINUTE_P50^MDC or 8411137^MDC_SABTE_VOL_MINUTE_P90^MDC or 8411138^MDC_SABTE_VOL_MINUTE_P95^MDC or 8411139^MDC_SABTE_VOL_MINUTE_INSTANT^MDC | 1.0.0.33 | |
| Tidal volume | NM | 8411169^MDC_SABTE_VOL_TIDAL_MIN^MDC or 8411170^MDC_SABTE_VOL_TIDAL_MAX^MDC or | 1.0.0.34 | |

**Table E.44 – Sleep apnoea breathing therapy equipment (SABTE) OBX encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| | | 8411171^MDC_SABTE_VOL_TIDAL_MEAN^MDC or 8411175^MDC_SABTE_VOL_TIDAL_P50^MDC or 8411177^MDC_SABTE_VOL_TIDAL_P90^MDC or 8411178^MDC_SABTE_VOL_TIDAL_P95^MDC or 8411179^MDC_SABTE_VOL_TIDAL_INSTANT^MDC | | |

**Table E.45 – Sleep apnoea breathing therapy equipment (SABTE) OBX encoding – Part 2**

| Description | OBX-6 | OBX-18 | OBX-20 |
|---|---|---|---|
| Sleep apnoea breathing therapy equipment (SABTE) MDS | | 0123456789ABCDEF^^0123456789ABCDEF^EUI-64 | |
| PHD DM device status | | | |
| Duration of flow generation | 264352^MDC_DIM_MIN^MDC | | |
| Duration of patient use | 264352^MDC_DIM_MIN^MDC | | |
| Snoring duration | 264352^MDC_DIM_MIN^MDC | | |
| Cheyne-Stokes respiration (CSR) duration | 264352^MDC_DIM_MIN^MDC | | |
| Ramp duration setting | 264352^MDC_DIM_MIN^MDC | | |
| Airflow waveform | 264992^MDC_DIM_L_PER_MIN^MDC | | |
| Airflow waveform sample period | 264320^MDC_DIM_SEC^MDC or 264339^MDC_DIM_MICRO_SEC^MDC | | |
| Apnoea-Hypopnoea-Index (AHI) compound of uAHI, oAHI and cAHI | | | |

**Table E.45 – Sleep apnoea breathing therapy equipment (SABTE) OBX encoding – Part 2**

| Description | OBX-6 | OBX-18 | OBX-20 |
|---|---|---|---|
| uAHI | 266876^MDC_DIM_EVT_PER_HR^MDC | | |
| oAHI | 266876^MDC_DIM_EVT_PER_HR^MDC | | |
| cAHI | 266876^MDC_DIM_EVT_PER_HR^MDC | | |
| Apnoea-Hypopnoea-Index (AHI) | 266876^MDC_DIM_EVT_PER_HR^MDC | | |
| Humidifier level setting | 262688^MDC_DIM_PERCENT^MDC | | |
| Trigger sensitivity setting | 262688^MDC_DIM_PERCENT^MDC | | |
| Inspiration pressure rise setting | 262688^MDC_DIM_PERCENT^MDC | | |
| Pressure adaption level setting | 262688^MDC_DIM_PERCENT^MDC | | |
| Pressure adaption freeze setting | | | |
| Autostart/-stop setting | | | |
| Device mode setting | | | |
| Therapy mode setting | | | |
| Compliance annotations | | | |
| Efficacy annotations | | | |
| Therapy pressure waveform | 265986^MDC_DIM_HECTO_PASCAL^MDC | | |
| Therapy pressure waveform sample period | 264320^MDC_DIM_SEC^MDC or 264339^MDC_DIM_MICRO_SEC^MDC | | |
| Therapy pressure | 265986^MDC_DIM_HECTO_PASCAL^MDC | | |
| Continuous positive airway pressure (P CPAP) setting | 265986^MDC_DIM_HECTO_PASCAL^MDC | | |
| Minimal automatic positive airway pressure (Pmin APAP) setting | 265986^MDC_DIM_HECTO_PASCAL^MDC | | |
| Maximal automatic positive airway pressure (Pmax APAP) setting | 265986^MDC_DIM_HECTO_PASCAL^MDC | | |
| Inspiratory positive airway pressure (P | 265986^MDC_DIM_HECTO_PASCAL^MDC | | |

**Table E.45 – Sleep apnoea breathing therapy equipment (SABTE) OBX encoding – Part 2**

| Description | OBX-6 | OBX-18 | OBX-20 |
|---|---|---|---|
| IPAP) setting | | | |
| Expiratory positive airway pressure (P EPAP) setting | 265986^MDC_DIM_HECTO_PASCAL^MDC | | |
| Ramp start pressure setting | 265986^MDC_DIM_HECTO_PASCAL^MDC | | |
| Respiratory rate | 264928^MDC_DIM_RESP_PER_MIN^MDC | | |
| Respiratory rate setting | 264928^MDC_DIM_RESP_PER_MIN^MDC | | |
| I:E ratio | 262688^MDC_DIM_PERCENT^MDC | | |
| I:E ratio setting | 262688^MDC_DIM_PERCENT^MDC | | |
| Leakage waveform | 264992^MDC_DIM_L_PER_MIN^MDC | | |
| Leakage waveform sample period | 264320^MDC_DIM_SEC^MDC or 264339^MDC_DIM_MICRO_SEC^MDC | | |
| Leakage | 264992^MDC_DIM_L_PER_MIN^MDC | | |
| Respiratory minute volume | 264992^MDC_DIM_L_PER_MIN^MDC | | |
| Tidal volume | 263762^MDC_DIM_MILLI_L^MDC | | |

### E.3.15 ISO/IEEE 11073-10425 continuous glucose monitor

#### E.3.15.1 Modelling

The continuous glucose monitor (CGM) object model consists of a single key observation type, glucose. The other objects that may provide additional information, e.g., glucose trend, may be linked to a particular source observation through a Source-Handle-Reference FACET-level OBX.

#### E.3.15.2 Transformations

The following transformations are performed in the encoding of this device.

- Several nomenclature codes have been harmonized with the underlying base codes. They are pointed out in the tables below.

### E.3.15.3 Containment tree

Table E.46 shows a continuous glucose monitor containment tree.

**Table E.46 – Continuous glucose monitor containment tree**

| REFID | Description |
|---|---|
| MDC_DEV_SPEC_PROFILE_CGM | Continuous glucose monitor (CGM) MDS |
| ... MDC_CONC_GLU_ISF or<br>... MDC_CONC_GLU_CAPILLARY_WHOLEBLOOD or<br>... MDC_CONC_GLU_CAPILLARY_PLASMA or<br>... MDC_CONC_GLU_VENOUS_WHOLEBLOOD or<br>... MDC_CONC_GLU_VENOUS_PLASMA or<br>... MDC_CONC_GLU_ARTERIAL_WHOLEBLOOD or<br>... MDC_CONC_GLU_ARTERIAL_PLASMA or<br>... MDC_CONC_GLU_CONTROL<br>... MDC_CONC_GLU_UNDETERMINED_WHOLEBLOOD or<br>... MDC_CONC_GLU_UNDETERMINED_PLASMA or | Glucose |
| ... MDC_PHD_DM_DEV_STAT | Personal health device disease management device status |
| ... MDC_CGM_DEV_STAT | CGM status |
| ... MDC_CGM_SENSOR_CALIBRATION | Sensor calibration |
| ... MDC_CGM_SENSOR_RUN_TIME | Sensor run-time |
| ... MDC_CGM_SENSOR_SAMPLE_INTERVAL | Glucose sample interval |
| ... MDC_CONC_GLU_TREND | Glucose trend |
| ... MDC_CONC_GLU_PATIENT_THRESHOLDS_LOW_HIGH | Patient low/high Thresholds |
| ... MDC_CONC_GLU_THRESHOLDS_HYPO_HYPER | Device hypo/hyper thresholds |
| ... MDC_CONC_GLU_RATE_THRESHOLDS | Glucose rate of change thresholds |

### E.3.15.5 OBX encoding

Table E.47 and Table E.48 show part 1 and part 2 (respectively) of a continuous glucose monitor OBX encoding.

**Table E.47 – Continuous glucose monitor encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| Continuous glucose monitor (CGM) MDS | | 528410^MDC_DEV_SPEC_PROFILE_CGM^MDC | 1 | |
| Glucose | NM | 160212^MDC_CONC_GLU_ISF^MDC or<br>160184^MDC_CONC_GLU_CAPILLARY_WHOLEBLOOD^MDC or<br>160188^MDC_CONC_GLU_CAPILLARY_PLASMA^MDC or<br>160192^MDC_CONC_GLU_VENOUS_WHOLEBLOOD^MDC or<br>160196^MDC_CONC_GLU_VENOUS_PLASMA^MDC or<br>160200^MDC_CONC_GLU_ARTERIAL_WHOLEBLOOD^MDC or<br>160204^MDC_CONC_GLU_ARTERIAL_PLASMA^MDC or<br>160208^MDC_CONC_GLU_CONTROL^MDC or<br>160364^MDC_CONC_GLU_UNDETERMINED_WHOLEBLOOD or<br>160368^MDC_CONC_GLU_UNDETERMINED_PLASMA | 1.0.0.1 | 15.8 |
| PHD DM status | CWE | 8408608^MDC_PHD_DM_DEV_STAT^MDC | 1.0.0.2 | One of the values…<br><0 or 1>^device-status-undetermined(0),<br><0 or 1>^device-status-reset(1),<br><0 or 1>^device-status-error(5),<br><0 or 1>^device-status-error-mechanical(6), |

**Table E.47 – Continuous glucose monitor encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| | | | | <0 or 1>^device-status-error-electronic(7),<br><0 or 1>^device-status-error-software(8),<br><0 or 1>^device-status-error-battery(9),<br><0 or 1>^device-status-service(15),<br><0 or 1>^device-status-service-time-sync-required(16),<br><0 or 1>^device-status-service-calibration-required(17),<br><0 or 1>^device-status-service-replenishment-required(18),<br><0 or 1>^device-status-battery-low(25),<br><0 or 1>^device-status-battery-depleted(26),<br><0 or 1>^device-status-battery-replaced(27),<br><0 or 1>^device-status-battery-interrupted(28) |
| CGM status | CWE | 8418060^MDC_CGM_DEV_STAT^MDC | 1.0.0.3 | One of the values…<br><0 or 1>^sensor-session-stopped(0),<br><0 or 1>^sensor-type-incorrect(2),<br><0 or 1>^sensor-manfunction(3),<br><0 or 1>^device-specific-alert(4),<br><0 or 1>^sensor-calibration-not-allowed(7),<br><0 or 1>^sensor-calibration-not-recommended(8),<br><0 or 1>^sensor-calibration-not-required(9),<br><0 or 1>^sensor-temp-too-high(10),<br><0 or 1>^sensor-temp-too-low(11), |

**Table E.47 – Continuous glucose monitor encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| | | | | <0 or 1>^sensor-result-below-patient-low(12),<br><0 or 1>^sensor-result-above-patient-high(13),<br><0 or 1>^sensor-low-hypo(14),<br><0 or 1>^sensor-low-hyper(15),<br><0 or 1>^sensor-rate-decrease-exceeded(16),<br><0 or 1>^sensor-rate-increase-exceeded(17),<br><0 or 1>^sensor-result-too-low(18),<br><0 or 1>^sensor-result-too-high(19),<br><0 or 1>^sensor-com-out-of-range(20) |
| Sensor calibration | NM | 8418036^MDC_CGM_SENSOR_CALIBRATION^MDC | 1.0.0.4 | 6.4 |
| Sensor run-time | NM | 8418040^MDC_CGM_SENSOR_RUN_TIME^MDC | 1.0.0.5 | 168 |
| Glucose sample interval | NM | 8418044^MDC_CGM_SENSOR_SAMPLE_INTERVAL^MDC | 1.0.0.6 | 15 |
| Glucose trend | NM | 8418008^MDC_CONC_GLU_TREND^MDC | 1.0.0.7 | 0.2 |
| Patient low/high thresholds | | 8418012^MDC_CONC_GLU_PATIENT_THRESHOLDS_LOW_HIGH^MDC | 1.0.1.0 | |
| Patient low threshold | NM | 8418013^MDC_CONC_GLU_PATIENT_THRESHOLD_LOW^MDC | 1.0.1.1 | 4.0 |
| Patient high threshold | NM | 8418014^MDC_CONC_GLU_PATIENT_THRESHOLD_HIGH^MDC | 1.0.1.2 | 8.0 |
| Device hypo/hyper thresholds | | 8418016^MDC_CONC_GLU_THRESHOLDS_HYPO_HYPER^MDC | 1.0.2.0 | |

**Table E.47 – Continuous glucose monitor encoding – Part 1**

| Description | OBX-2 | OBX-3 | OBX-4 | OBX-5 |
|---|---|---|---|---|
| Device hypo threshold | NM | 8418017^MDC_CONC_GLU_THRESHOLD_HYPO^MDC | 1.0.2.1 | 2.0 |
| Device hyper threshold | NM | 8418018^MDC_CONC_GLU_THRESHOLD_HYPER^MDC | 1.0.2.2 | 20.0 |
| Glucose rate of change thresholds | | 8391520^MDC_CONC_GLU_RATE_THRESHOLDS^MDC | 1.0.3.0 | |
| Glucose rate of change increase threshold | NM | 8391521^MDC_CONC_GLU_RATE_THRESHOLD_INCREASE^MDC | 1.0.3.1 | 0.5 |
| Glucose rate of change decrease threshold | NM | 8391522^MDC_CONC_GLU_RATE_THRESHOLD_DECREASE^MDC | 1.0.3.2 | 0.5 |

**Table E.48 – Insulin pump encoding – Part 2**

| Description | OBX-6 | OBX-18 | OBX-20 |
|---|---|---|---|
| Insulin pump MDS | | 0123456789ABCDEF^^0123456789ABCDEF^EUI-64 | |
| Bolus delivered | 267616^MDC_DIM_X_INTL_UNIT^MDC | | |
| Current basal rate setting | 267840^MDC_DIM_X_INTL_UNIT_PER_HR^MDC | | |
| PHD DM device status | | | |
| Insulin pump status | | | |
| Operational and therapy conditions | | | |
| Current bolus setting | 267616^MDC_DIM_X_INTL_UNIT^MDC or 267840^MDC_DIM_X_INTL_UNIT_PER_HR^MDC | | |

## Table E.48 – Insulin pump encoding – Part 2

| Description | OBX-6 | OBX-18 | OBX-20 |
|---|---|---|---|
| Pending bolus delay | 264352^MDC_DIM_MIN^MDC or 264320^MDC_DIM_SEC^MDC or | | |
| Basal delivered | 267616^MDC_DIM_X_INTL_UNIT^MDC | | |
| Insulin reservoir remaining | 267616^MDC_DIM_X_INTL_UNIT^MDC | | |
| Insulin concentration | 267712^MDC_DIM_X_INTL_UNIT_PER_L^MDC or 267744^MDC_DIM_X_INTL_UNIT_PER_ML^MDC or 267680^MDC_DIM_X_INTL_UNIT_PER_M_CUBE^MDC or 267648^MDC_DIM_X_INTL_UNIT_PER_CM_CUBE^MDC | | |

## E.4 HL7 Unsolicited observation result

The intent of this clause is to provide a quick reference of the HL7 Unsolicited Observation Result (ORU^R01^ORU_R01) detail from the services interface usage point of view. To this extent, these tables subset the full information and present only the core data needed. For further information please refer to the IHE PCD Technical Framework [IHE PCD-TF-2] and/or Chapter 2 (Control) of [HL7 2.6].

The following applies to the usage column found in the tables listed in the following subclauses:

– Shading indicates fields that would have to be present in a minimal message. Please note that, by convention, a segment should terminate after its last non-empty sequence.

– All entries whose usage indicator is 'X' shall be empty.

– The '<' and '>' symbols used in the table below are NOT part of the encoding; they are just helpers to delineate the description of the fields.

– The Data types are given in clause E.5.

– The following notation is used (also in clauses E.5 and E.6):

  - C=conditionally required;
  - CE=conditionally required but may be empty;
  - O=optional;
  - R=required;
  - RE=required but may be empty;
  - X=not supported.

### E.4.1 MSH

The specifications in this clause are derived from the IHE PCD Technical Framework [IHE PCD-TF-2], Appendix B.

The Message header segment is the first segment of every message. It contains the core common information that applies for the entire message. This segment is required.

Table E.49 shows the core data in a message header segment.

**Table E.49 – Message header segment**

<table>
<tr><th>Element</th><th>Usage</th><th>Data type</th><th>Element name</th><th>Value</th></tr>
<tr><td>MSH-1</td><td>R</td><td>ST</td><td>Field separator</td><td>Shall be '|'. PCD-01 constrains to the character '|'</td></tr>
<tr><td>MSH-2</td><td>R</td><td>ST</td><td>Encoding characters</td><td>Shall be '^~\&'. PCD-01 constrains to the characters '^~\&'</td></tr>
<tr><td>MSH-3</td><td>R</td><td>HD</td><td>Sending application</td><td>Uniquely specify the sending application.<br>The data type ID shall be EUI-64.<br>The Universal ID shall be the PHG's system ID.<br>The Namespace ID should not be empty. A non-empty entry makes the document more human readable. (Note – Not to be confused with an XML namespace.)<br>Encoded as<br><Namespace ID (data type IS)>^<Universal ID (data</td></tr>
</table>

**Table E.49 – Message header segment**

| Element | Usage | Data type | Element name | Value |
|---|---|---|---|---|
| | | | | type ST)^<Universal ID Type (data type ID)><br>Example:<br>'ORIGatewayInc^ABCDE48234567ABCD^EUI-64' |
| MSH-4 | RE | HD | Sending facility | Uniquely specifies the sending facility |
| MSH-5 | RE | HD | Receiving application | Uniquely specifies specify the receiving application |
| MSH-6 | RE | HD | Receiving facility | Uniquely specifies the receiving facility |
| MSH-7 | R | DTM | Date/Time of message | **Shall** be the time of the document completion.<br>To clarify the timestamp is when the PCD-01 document is completed and ready for sending. It is not the time of the sending or when one initializes the document in code. Thus if the network is down and the document is sent at a later time, this timestamp is NOT changed to the sending time.<br>Encoded as<br>YYYY[MM[DD[HH[MM[SS]]]]][+/−ZZZZ]<br>**Shall** contain the Time zone unless the PHG has lost synchronization and is falling back to using unqualified time.<br>A Continua compliant services sender shall be UTC aware and should be local time aware. However, error conditions may prevent the PHG from being able to obtain appropriate time information. This specification allows for the same relaxation of the timestamp generation as in reporting the measurement timestamps.<br>Examples:<br>20090726095730+0000 qualified; in GMT time zone<br>20090726095730-0000 qualified; time zone unknown<br>20090726045730-0500 qualified; in non GMT zone<br>20090726045730 unqualified fallback |
| MSH-8 | X | ST | Security | |
| MSH-9 | R | MSG | Message type | This field specifies the message type, trigger event and the message structure ID for the message. For PCD-01 it is the unsolicited request code ORU^R01^ORU_R01<br>Encoded as<br><Message Code (data type ID)>^<Trigger Event (data type ID)>^<Message Structure (data type ID)><br>**Shall** be 'ORU^R01^ORU_R01' |
| MSH-10 | R | ST | Message control Id | This Id is echoed back in the acknowledgement. When combined with the sending application in MSH-3, this value shall be uniquely identified.<br>Example:<br>'MSGID123456789' |

**Table E.49 – Message header segment**

| Element | Usage | Data type | Element name | Value |
|---|---|---|---|---|
| MSH-11 | R | PT | Processing Id | This field specifies whether to process the message using HL7 defined processing rules.<br>Encoded as<br><Processing ID (data type ID)>^<Processing Mode (data type ID)><br>PCD-01 constrains 'Processing ID' to come from HL7 2.6, table 0103 and 'Processing Mode' to come from HL7 2.6, table 0207 (if it is valued).<br>Example:<br>'P' for production is the typical value. There is also 'D' for debugging and 'T' for training<br>Processing ID shall be present. |
| MSH-12 | R | VID | Version Id | This field is the HL7 V2.x version of the message.<br>Encoded as<br><Version ID (data type ID)>^<Internationalization Code (data type CWE)>^International Version ID (data type CWE)><br>**Shall** be '2.6'. PCD-01 constrains this to '2.6' |
| MSH-13 | RE | NM | Sequence number | If valued, this number implies that the sequence number protocol is in use. This number would be incremented by one for each subsequent value.<br>**Should not** be valued. The value is not used in IHE PCD |
| MSH-14 | X | ST | Continuation pointer | |
| MSH-15 | R | ID | Accept acknowledgement type | This field specifies when an accept acknowledgement is required in response to the message. (PCD-01 is an unsolicited request and since no formal request has been issued there is nothing to acknowledge.)<br>**Shall** be set to 'NE' for "never" |
| MSH-16 | R | ID | Application acknowledgement type | This specifies when an application acknowledgement is required in response to the message.<br>**Shall** be set to 'AL' for always |
| MSH-17 | RE | ID | Country code | |
| MSH-18 | RE | ID | Character set | When empty it means the message is coded in ASCII-127. |
| MSH-19 | RE | CWE | Principal language of message | When empty it defaults to EN^English^ISO659. |
| MSH-20 | X | ID | Alternate character set handling scheme | |
| MSH-21 | R | EI | Message profile identifier | This field contains the formal registered name of the message profile that the message adheres to.<br>Encoded as |

**Table E.49 – Message header segment**

| Element | Usage | Data type | Element name | Value |
|---|---|---|---|---|
| | | | | <Entity Identifier (data type ST)>^<Namespace ID (data type IS)>^<Universal ID (data type ST)>^<Universal ID Type (data type ID)><br>Example<br>'IHE PCD ORU-R012006^HL7^2.16.840.1.113883.9.n.m^HL7' |
| MSH-22 | X | XON | Sending Responsible Organization | Business organization that originated the message and is legally accountable. **Shall not** be valued |
| MSH-23 | O | XON | Receiving Responsible Organization | Business organization that is intended receiver of message and is legally accountable for operating on it |
| MSH-24 | O | HD | Sending Network Address | Identifier of network location of sender |
| MSH-25 | O | HD | Receiving Network Address | Identifier of network location of receiver |

### E.4.2 PID

The specifications in this clause are derived from the IHE PCD Technical Framework [IHE PCD-TF-2], Appendix B.

The Patient identification segment conveys the relevant patient information for the subsequent observations. This segment is required.

Table E.50 shows the core data in a patient identification segment.

**Table E.50 – Patient identification segment**

| Element | Usage | DT | Element name | Value |
|---|---|---|---|---|
| PID-1 | X | SI | Set ID – PID | |
| PID-2 | X | CX | Patient ID | |
| PID-3 | R | CX | Patient Identifier List | A list of identifiers that uniquely identify the patient. See clause E.5.1 for more information on the CX data type. Subfields CX-1, CX-4 and CX-5 shall be non-empty.<br>Example:<br>789567^^^Imaginary Hospital^PI<br>28da0026bc42484^^^&1.19.6.24.109.42.1.3&ISO^PI |
| PID-4 | X | CX | Alternate Patient ID – PID | |
| PID-5 | R | XPN | Patient Name | This field contains the name(s) of the patient. The legal name ('L'), if present, shall occur first. See clause E.5.7 for more information on the XPN data type.<br>Example:<br>Clemens^Samuel^Langhorne^^^^L |

**Table E.50 – Patient identification segment**

| Element | Usage | DT | Element name | Value |
|---|---|---|---|---|
| PID-6 | RE | XPN | Mother's Maiden Name | Mother's family birth name before marriage. May be valued. The legal name ('L'), if present, shall occur first.<br>Example:<br>Langdon^Olivia^^^^^L |
| PID-7 | RE | DTM | Date/Time of Birth | Date and Time of birth.<br>Encoded as<br>YYYY[MM[DD[HH[MM[SS]]]]][+/−ZZZZ]<br>Time zone is required.<br>Example:<br>'20090726095730-0500' |
| PID-8 | RE | IS | Administrative Sex | Code that denotes the patient's sex.<br>Example:<br>"F" for female; "M" for male |
| PID-9 | X | XPN | Patient Alias | |
| PID-10 | RE | CWE | Race | Code that denotes patient's race |
| PID-11 | RE | XAD | Patient Address | Mailing address of the patient<br>Example:<br>123 Main St.^^Raleigh^North Carolina^27613^M |
| PID-12 | X | IS | Country Code | |
| PID-13 | RE | XTN | Phone Number-Home | Patient's phone number. If valued, PCD-01 constrains this to two or fewer repetitions with primary phone number to be the first |
| PID-14 | X | XTN | Phone Number-Business | |
| PID-15 | RE | CWE | Primary Language | Code to denote patient's language. If valued, PCD-01 requires these terms to come from ISO639. May be valued |
| PID-16 | RE | CWE | Marital Status | Code to denote patient's marital status. May be valued |
| PID-17 | RE | CWE | Religion | Code to denote patient's religion. May be valued |
| PID-18 | RE | CX | Patient Account Number | Code to identify account patient charges are to be made to. May be valued |
| PID-19 | X | ST | SSN Number-Patient | |
| PID-20 | X | DLN | Driver's License Number-Patient | |
| PID-21 | RE | CX | Mother's Identifier | Used as a field for linkage to mother for newborns. May be valued |
| PID-22 | RE | CWE | Ethnic Group | Additionally define patient's heritage. May be valued |
| PID-23 | RE | ST | Birth Place | Augments PID-11. May be valued |
| PID-24 | RE | ID | Multiple Birth Indicator | Code to denote if patient was part of a multiple birth. May be valued |
| PID-25 | RE | NM | Birth Order | Denotes birth order for multiple birth participant. May be valued |

**Table E.50 – Patient identification segment**

| Element | Usage | DT | Element name | Value |
|---|---|---|---|---|
| PID-26 | RE | CWE | Citizenship | Patient's country citizenship. May be valued |
| PID-27 | RE | CWE | Veteran's Military Status | Code to denote military status. May be valued |
| PID-28 | X | CWE | Nationality | |
| PID-29 | RE | DTM | Patient Death Date and Time | Date and time of patient's death. May be valued |
| PID-30 | RE | ID | Patient Death Indicator | Code to denote whether patient is deceased. May be valued |
| PID-31 | RE | ID | Identity Unknown Indicator | Code to denote whether patient's identity is known. May be valued |
| PID-32 | RE | IS | Identity Reliability Code | Code to denote reliability of contained identity. May be valued |
| PID-33 | RE | DTM | Last Update Date/Time | Date/Time of last update to the patient's identifying and demographic data in this segment. May be valued |
| PID-34 | RE | HD | Last Update Facility | Identity of the facility that performed the last update to the patient's identifying and demographic data in this segment. May be valued |
| PID-35 | X | CWE | Species Code | No value is assumed to be human. Required but can be empty. **Shall not** be valued |
| PID-36 | X | CWE | Breed Code | Animal breed. **Shall not** be valued |
| PID-37 | X | ST | Strain | Animal strain. **Shall not** be valued |
| PID-38 | X | CWE | Production Class Code | Primary use for bred animal. **Shall not** be valued |
| PID-39 | X | CWE | Tribal Citizenship | Code to denote patient's tribal status. **Shall not** be valued |

### E.4.3 OBR

The specifications in this clause are derived from the IHE PCD Technical Framework [IHE PCD-TF-2], Appendix B.

The Observation request segment serves as the header to a group of observations. For services interface purposes, an important aspect of this segment is the time start/end boundaries for the OBX grouping to follow. This segment is required.

Table E.51 shows the core data in an observation request segment.

**Table E.51 – Observation request segment**

| Element | Usage | DT | Element name | Value |
|---|---|---|---|---|
| OBR-1 | R | SI | Set ID OBR | Sequence number of the order starting with 1 and increasing sequentially. |
| OBR-2 | R | EI | Placer Order Number | PCD-01 requires the 1st, 2nd and 3rd components of this field to be valued. If there is an existing order, this field shall be set to the identifier of the system that has placed that order. However, there is typically no unique |

**Table E.51 – Observation request segment**

| Element | Usage | DT | Element name | Value |
|---|---|---|---|---|
| | | | | order for device observations, but rather an assumed "standing order".<br>In this case, the first component is the order ID that is simply an arbitrary string, the second component contains an HD that identifies the application which implements the services client component, and the third component shall contain the EUI-64 of the device which implements the services client component.<br>Example:<br>AB12345^ORIGatewayInc ICU-04^ACDE48234567ABCD^EUI-64 |
| OBR-3 | R | EI | Filler Order Number | PCD-01 constrains the 1st, 2nd and 3rd components to be valued. However, there is typically no outstanding order for device observations, but rather an assumed "standing order".<br>In this case, the first component is an arbitrary order ID string, the second, third and fourth component are used like an HD to identify the application which implements the Services client component, and shall contain the EUI-64 of this device. For "standing orders", this value should match OBR-2.<br>Example:<br>AB12345^ORIGatewayInc ICU-04^ACDE48234567ABCD^EUI-64 |
| OBR-4 | R | CWE | Universal Service Identifier | This field shall contain the identifier code for the requested observation/test/battery. This can refer to specific existing orders, or nonspecific "standing" orders. "Universal" procedure codes from a code set recognized by HL7 should be used when available. Locally defined codes may be used by agreement where standardized codes are not available.^<br>^<br>When reporting events related to "standing" orders, as is common in patient monitoring, these codes will likely describe a generic service such as:^<br>266706003^continuous ECG monitoring^SNOMED-CT^<br>359772000^glucose monitoring at home^SNOMED-CT ^<br>182777000^monitoring of patient^SNOMED-CT |
| OBR-5 | X | ID | Priority – OBR | |
| OBR-6 | X | DTM | Requested Date/Time | |
| OBR-7 | RE | DTM | Observation Date/Time | This is the base time for the observations that follow. If any following OBX segments have a timestamp, it shall be equal to or greater than this value. If any following OBX segments do not have a timestamp, then it is assumed to be equal to this OBR time. However, Continua PCD-01 OBX segments that are physiological measurements will always have a |

**Table E.51 – Observation request segment**

| Element | Usage | DT | Element name | Value |
|---|---|---|---|---|
| | | | | timestamp. If the sensor device does not provide one, the PHG enters its time of reception as the timestamp. Thus this field shall always be valued.<br>Example:<br>20091225095715+0500 |
| OBR-8 | RE | DTM | Observation End Date/Time | This is the base end time for the observations that follow. If any following OBX segments have a timestamp, it shall be strictly less than this value. Note, *not less than or equal to*! If there is only one measurement this entry is not required.<br>Example:<br>20100101095715+0500 |
| OBR-9 through OBR-50 | | | | **Shall not** be valued. |

### E.4.4 OBX

The specifications in this clause are derived from the IHE PCD Technical Framework [IHE PCD-TF-2], Appendix B.

This segment is used to convey a single observation as well as the features, capabilities and status of the PHG and sensor device. This is the segment where all the observation detail is conveyed. This segment is required. In operation, Continua PCD-01 documents will always have several OBX segments for every OBR.

Table E.52 shows the core data in a single observation segment.

**Table E.52 – Single observation segment**

| Element | Usage | DT | Element name | Value |
|---|---|---|---|---|
| OBX-1 | R | SI | Set ID – OBX | Sequence number of the OBX in this message. |
| OBX-2 | C | ID | Value Type | HL7 data type of value in OBX-5. **Shall** be valued if OBX-5 is valued.<br>For a services interface usage the most common data types are<br>NM – numeric<br>CWE – coded with exceptions<br>ST – string<br>See HL7 data type detail in clause E.5.<br>Example (weight scale – weight):<br>NM |
| OBX-3 | R | CWE | Observation Identifier | An encoded string that uniquely identifies this observation type. This is typically the encoded version of the MDC code of the observation type or metric id. See clause E.5.1 for specifics on how this encoded.<br>Example (weight scale – weight):<br>188736^MDC_MASS_BODY_ACTUAL^MDC |

**Table E.52 – Single observation segment**

| Element | Usage | DT | Element name | Value |
|---|---|---|---|---|
| OBX-4 | R | ST | Observation Sub-ID | Contains the string representing the hierarchical identity of the observation.<br>Example (weight scale – weight):<br>1.0.0.15 |
| OBX-5 | C | varies | Observation Value | The actual observation value in the format appropriate for the specified data type in OBX-2.<br>Example (weight scale – weight):<br>153.6 |
| OBX-6 | C | CWE | Units | The encoded string that identifies the units for the observation value. This is typically the encoded version of the MDC code for the units. Empty if OBX-5 does not have any units.<br>Example (weight scale – weight):<br>263875^MDC_DIM_KILO_G^MDC |
| OBX-7 | CE | ST | References Range | The reference range for the observation.<br>Example:<br>3.5 – 4.5 |
| OBX-8 | CE | IS | Abnormal Flags | A coded value that conveys additional information about the observation. This field is used to convey the MeasurementStatus of each metric when it is reported by the personal health device. D.1.3.1.7 includes a table of IS codes to be used for the IEEE 11073 MeasurementStatus values, along with additional information on handling measurement status. It is also used to code the occurrences of the [ISO/IEEE 11073-20601] special values such as NaN, plus or minus infinity, etc. The codes are given by [IHE PCD-01] Appendix B.8 OBX-8 and in this document in Table D.8 and Table D.9. If this field is valued, it will have an influence on the value of OBX-11. |
| OBX-9 | X | NM | Probability | |
| OBX-10 | CE | ID | Nature of Abnormal Test | **Should not** be valued |
| OBX-11 | R | ID | Observation Result Status | This field conveys additional information about the observations quality/status.<br>For the services interface, a value of 'R' meaning 'results entered -- not verified', shall be used for unreviewed data captured directly by devices with no specific measurement status information. Note that 'X' is used if the OBX is not a physiological measurement. If the measurement is a physiological measurement and has an OBX-8 entry, the OBX-11 value is given by the table in [IHE PCD-01] Appendix B.8 OBX-8 and in this document in Table D.8 and Table D.9. |

**Table E.52 – Single observation segment**

| Element | Usage | DT | Element name | Value |
|---|---|---|---|---|
| OBX-12 | X | DTM | Effective Date of Reference Range | |
| OBX-13 | X | ST | User Defined Access Checks | |
| OBX-14 | RE | DTM | Date/Time of Observation | Optional timestamp specific to this observation. OBR has overall timestamp inherited by all observations if not overridden here. This timestamp shall be greater than or equal to the parent OBR-7. If OBR-8 is valued, then this timestamp shall be strictly less than OBR-8. This field will always be valued in Metric-OBXes in a Continua PCD-01 document. |
| OBX-15 | RE | CWE | Producer's ID | **Should not** be valued |
| OBX-16 | RE | XCN | Responsible Observer | **Should not** be valued |
| OBX-17 | RE | CWE | Observation Method | Coded entry used to denote the method or procedure by which the observation was obtained. In many cases the value specified in OBX-3 implies the method/procedure used in obtaining observation. If it does not then this field may be used to convey an appropriate MDC code |
| OBX-18 | RE | EI | Equipment Instance Identifier | **Should** be an EUI-64 which is unique to the originating device of this observation. For Continua devices this entry is only required for the MDS OBXes. See [IHE PCD-01] Appendix B.8 OBX-18.<br>Example:<br>The System-Id of the personal health device information source<br>012345678FEDCBA00^^012345678FEDCBA00^EUI-64 |
| OBX-19 | CE | DTM | Date/Time of Analysis | **Should not** be valued. Use of OBX-14 is preferred. If valued, this value shall duplicate the OBX-14 value |
| OBX-20 | RE | CWE | Observation Site | If valued, this field shall contain an appropriate MDC code for the observation. This field might be populated if there are appropriate supplemental types values. |
| OBX-21 to OBX-25 | | | | **Should not** be valued |

### E.4.5 PV1

The specifications in this clause are derived from the IHE PCD Technical Framework [IHE PCD-TF-2], Appendix B.

The patient visit segment details the visit specific data for an encounter. It includes account and physical location information. It is unlikely that this segment will be required for the services interface so the details have been omitted. Information on this segment can be found in [IHE PCD-TF-2] and Chapter 3 (Patient Administration) of [HL7 2.6].

### E.4.6 NTE

The specifications in this clause are derived from the IHE PCD Technical Framework [IHE PCD-TF-2], Appendix B.

The Note segment can be used for all manner of auxiliary descriptive text to send with the message. The PCD-01 limits its usage to only after the OBR and OBX segments.

Table E.53 shows the core data in a note segment.

**Table E.53 – Note segment**

| Element | Usage | DT | Element name | Value |
|---|---|---|---|---|
| NTE-1 | R | SI | Set ID | Number is required for distinguishing when multiple NTE segments appear in a message |
| NTE-2 | X | ID | Source of comment | |
| NTE-3 | RE | FT | Comment | The text of the comment |
| NTE-4 | X | CWE | Comment Type | |
| NTE-5 | O | XCN | Entered by | |
| NTE-6 | O | DTM | Entered Date/Time | |
| NTE-7 | O | DTM | Effective start date | |
| NTE-8 | O | DTM | Expiration date | |

### E.4.7 TQ1

The specifications in this clause are derived from the IHE PCD Technical Framework [IHE PCD-TF-2], Appendix B.

The Timing/Quantity segment details the timing and execution of events and actions. It includes quantity, frequency, priority and timing information. This segment **should not** be used on the services interface. It is unlikely that this segment will be required for the services interface, so the details have been omitted. Information on this segment can be found in [IHE PCD-TF-2] and Chapter 4 (Order Entry) of [HL7 2.6].

### E.4.8 MSA

The specifications in this clause are derived from the IHE PCD Technical Framework [IHE PCD-TF-2], Appendix B.

The message acknowledgement segment contains the information communicated when acknowledging a message.

Table E.54 shows the core data in a message acknowledgement segment.

**Table E.54 – Message acknowledgement segment**

| Element | Usage | DT | Element name | Value |
|---|---|---|---|---|
| MSA-1 | R | ID | Acknowledgement Code | This shall be one of the values found at:http://www.ihe.net/Technical_Framework/upload/IHE_PCD_TF_Vol2_FT_2011-08-12.pdf |
| MSA-2 | R | ST | Message Control Id | This field contains the message control ID from the MSH-10 (Message Control ID) of the incoming message for which this acknowledgement is being sent |

**Table E.54 – Message acknowledgement segment**

| Element | Usage | DT | Element name | Value |
|---|---|---|---|---|
| MSA-3 | X | ST | Text Message | |
| MSA-4 | X | NM | Expected Sequence Number | |
| MSA-5 | X | ID | Delayed Acknowledgement Type | |
| MSA-6 | X | CE | Error Condition | |
| MSA-7 | X | NM | Message Waiting Number | |
| MSA-8 | X | ID | Message Waiting Priority | |

### E.4.9 ERR

The specifications in this clause are derived from the IHE PCD Technical Framework [IHE PCD-TF-2], Appendix B.

This segment is used to add comments about an error to the acknowledgement message with an Acknowledgement Code of 'Application Error'. However, this segment **may** be transmitted with any Acknowledgement message including messages that have no error ('message accepted') as the segment can be used to transfer user information. Messages are to be accepted/rejected in their entirety, so if a services observation receiver device reports an ERR segment with severity E (Error) or F (Fatal Error), the Message acknowledgement value **shall** be AE (Application Error) or AR (Application Reject).

Table E.55 shows the core data in an error segment.

**Table E.55 – Error segment**

| Element | Usage | DT | Element name | Value |
|---|---|---|---|---|
| ERR-1 | RE | ELD | Error code and location | Shall not be valued.<br>ERR-1 is included in HL7 2.6 for backward compatibility only. |
| ERR-2 | O | ERL | Error location | Should be valued with the location in the message related to the identified error, warning, or message. This field is repeated for errors which result from the combination of multiple locations.<br>Components: <Segment ID(ST)>^<Segment Sequence(NM)>^<Field Position(NM)>^<Field Repetition(NM)>^<Component Number(NM)>^<Sub-Component Number(NM)> |
| ERR-3 | R | CWE | HL7 error code | If the ERR segment is transmitted, this value shall be set to a valid error code defined in Table E.53 |
| ERR-4 | R | ID | Severity | If the ERR segment is transmitted, this value shall be set to a valid error code defined in Table E.52 |
| ERR-5 | O | CWE | Application error code | |

**Table E.55 – Error segment**

| Element | Usage | DT | Element name | Value |
|---|---|---|---|---|
| ERR-6 | O | ST | Application error parameter | |
| ERR-7 | O | TX | Diagnostic information | |
| ERR-8 | O | TX | User message | |
| ERR-9 | O | IS | Inform person indicator | |
| ERR-10 | O | CWE | Override type | |
| ERR-11 | O | CWE | Override reason code | |
| ERR-12 | O | XTN | Help desk contact point | |

### E.4.10 HL7 v2.6 error tables

Table E.56 shows HL7 Table 0357 with message error condition codes and Table E.57 shows HL7 Table 0516, which indicates error severity.

**Table E.56 – HL7 Table 0357 – Message error condition code**

| Value | Description | Comment |
|---|---|---|
| 0 | Message accepted | Success. Optional, as the AA conveys success. Used for systems that must always return a status code |
| 100 | Segment sequence error | Error: The message segments were not in the proper order, or required segments are missing |
| 101 | Required field missing | Error: A required field is missing from a segment |
| 102 | Data type error | Error: The field contained data of the wrong data type, e.g., an NM field contained "FOO" |
| 103 | Table value not found | Error: A field of data type ID or IS was compared against the corresponding table, and no match was found |
| 200 | Unsupported message type | Rejection: The Message Type is not supported |
| 201 | Unsupported event code | Rejection: The Event Code is not supported |
| 202 | Unsupported processing id | Rejection: The Processing ID is not supported |
| 203 | Unsupported version id | Rejection: The Version ID is not supported |
| 204 | Unknown key identifier | Rejection: The ID of the patient, order, and etc., was not found. Used for transactions other than additions, e.g., transfer of a non-existent patient |
| 205 | Duplicate key identifier | Rejection: The ID of the patient, order, and etc., already exists. Used in response to addition transactions (Admit, New Order, and etc.) |
| 206 | Application record locked | Rejection: The transaction could not be performed at the application storage level, e.g., database locked |
| 207 | Application internal error | Rejection: A catch-all for internal errors not explicitly covered by other codes |

**Table E.57 – HL7 Table 0516 – Error severity**

| Value | Description | Comment |
|---|---|---|
| W | Warning | Transaction successful, but there many issues |
| I | Information | Transaction was successful but includes information e.g., inform patient |
| E | Error | Transaction was unsuccessful |
| F | Fatal Error | Message not processed due to application or network failure condition |

## E.5 HL7 Data types – Observations

The data types in Table E.58 are derived from Appendix C "*Common Data Types*" of [IHE PCD TF-2] and chapter 2.15, (Table 0440 – Data Types) of [HL7 2.6].

**Table E.58 – HL7 data types used in OBX-2**

| Data type | Data type name | LEN | Category | Comment |
|---|---|---|---|---|
| CF | Coded element with formatted values | 65536 | Code Values | |
| CWE | Coded with exceptions | 705 | Code Values | |
| DT | Date | 8 | Date/Time | |
| DTM | Date/time | 24 | | |
| ED | Encapsulated data | 65536 | Specialty/Chapter Specific | Supports ASCII MIME-encoding of binary data |
| FT | Formatted text | 65536 | Alphanumeric | |
| NA | Numeric array<br>NOTE – Numeric Array is not a valid data type for OBX-3 according to [HL7 2.6] 7.4.2, Table 0125 but is explicitly allowed on the Continua Services interface in order to report waveform data such as RT-SA metrics from [ISO/IEEE 11073-20601]. | 65536 | Specialty/Chapter Specific: waveform | For waveform data only |
| NM | Numeric | 16 | Numerical | |
| SN | Structured numeric | 36 | Numerical | |
| ST | String | 199 | Alphanumeric | |
| TM | Time | 16 | Date/Time | |
| TX | Text data | 65536 | Alphanumeric | |
| XAD | Extended address | 631 | Demographics | Replaces AD as of v 2.3 |
| XCN | Extended composite ID number and name | 3002 | Code Values | Replaces CN as of v 2.3 |
| XON | Extended composite name and ID number for organizations | 567 | Demographics | |
| XPN | Extended person name | 1103 | Demographics | Replaces PN as of v 2.3 |

### E.5.1 CWE

The specifications in this clause are derived from the IHE PCD Technical Framework [IHE PCD-TF-2], Appendix C.

Table E.59 shows the details for the coded with exceptions (CWE) data type.

**Table E.59 – CWE**

| Name | Usage | DT | Comment |
|---|---|---|---|
| Identifier | R | ST | This is the actual code, unique to the coding system in component 3.<br>For MDC codes this value shall be the integer formed by treating the code partition as the high 16 bits of a 32 bit number and the particular code as the lower 16 bits.<br>Example:<br>MDC_MASS_BODY_ACTUAL has value 57664 in partition MDC_PART_SCADA. So this would be 2::57664.<br>(2 * 65536) + 57664 = 188736. So the identifier would be 188736.<br>For values derived from ASN.1 BITS fields, this value shall be '1' for "true" or "on" and '0' for "false" or "off" |
| Text | RE | ST | This is the textual form of the code point.<br>PCD-01 specifies this field usage as 'R', but for services interface usage this has been relaxed to 'RE'. This value should be present if known.<br>For MDC codes, this value shall match the normative Reference Id of the nomenclature code if known.<br>Example: Continuing the previous example this field would be valued "MDC_MASS_BODY_ACTUAL".<br>For values derived from ASN.1 BITS fields, this value shall match the normative identifier of the bit field's name if known, followed by the bit position in parentheses |
| Name of Coding System | RE | ID | This is the name of the coding scheme used for the identifier/text. For MDC codes, this shall be set to 'MDC'<br>For values derived from ASN.1 BITS fields, this value shall not be valued |
| Alternate Identifier | RE | ST | Typically not used for services interface |
| Alternate Text | RE | ST | Rarely used for the services interface but used encoding the Unit-LabelString attribute value to the Unit-Code attribute value |
| Name of Alternate Coding System | RE | ID | Typically not used for services interface |
| Coding System Version ID | C | ST | Typically not used for services interface |
| Alternate Coding System Version ID | O | ST | Typically not used for services interface |
| Original Text | O | ST | Typically not used for services interface |

#### E.5.1.1 Examples

```
'188736^MDC_MASS_BODY_ACTUAL^MDC'
'263075^MDC_DIM_KILO_G^MDC'
```

### E.5.2 DTM

The date/time data type is a string encoded as follows:

– YYYY[MM[DD[HH[MM[SS[.S[S[S[S]]]]]]]]][+/−ZZZZ]

– −0000 is used to indicate a DTM that is UTC aware but not local time aware.

– 0000 indicates a DTM that is both UTC and local time aware and happens to be in a GMT time zone.

#### E.5.2.1 Example

```
'20090726095730+0000'
```

### E.5.3 NM

The numeric is a sequence of characters that specify a number. Only digits, '+', '−' and '.' Characters are allowed.

#### E.5.3.1 Examples

```
123
-57.633
```

### E.5.4 ST

The string data type is merely character data.

#### E.5.4.1 Example

```
"arbitrary collection of characters"
```

### E.5.5 NA - numeric array

The specifications in this clause are extracted from 2.A Data Types of [HL7 2.6].

Table E.60 describes the HL7 component table for a numeric array data type.

**Table E.60 – HL7 component table – numeric array**

| SEQ | LEN | DT | OPT | TBL# | COMPONENT NAME | COMMENTS | SEC.REF. |
|---|---|---|---|---|---|---|---|
| 1 | 16 | NM | R | | Value1 | | |
| 2 | 16 | NM | O | | Value2 | | |
| 3 | 16 | NM | O | | Value3 | | |
| 4 | 16 | NM | O | | Value4 | | |

Definition: This data type is used to represent a series (array) of numeric values. A field of this type may contain a one-dimensional array (vector or row) of numbers. Also, by allowing the field to repeat, a two-dimensional array (table) of numbers may be transmitted using this format, with each row of the table represented as one repetition of the field. Arrays that have one or more values not present may be transmitted using this data type. "Not present" values are represented as two adjacent component delimiters. If the absent values occur at the end of a row, the trailing component delimiters may be omitted. If an entire row of a table has no values, no component delimiters are necessary (in this case, there will be two adjacent repetition delimiters).

**Maximum length:** 65536

### E.5.5.1 Example 1: vector of eight numbers

```
|125^34^-22^-234^569^442^-212^6|
```

### E.5.5.2 Example 2:3 x 3 array of numbers

```
|1.2^-3.5^5.2~2.0^3.1^-6.2~3.5^7.8^-1.3|
```

### E.5.5.3 Example 3: 5 x 4 array of numbers with the values in positions (1,1), (2,2), (2,3), (3,3), (3,4), (4,1), (4,2), (4,3) and (4,4) not present

```
|^2^3^4~5^^^8~9^10~~17^18^19^20|
```

## E.5.6 XAD

The specifications in this clause are derived from the IHE PCD Technical Framework [IHE PCD-TF-2], Appendix C.

Table E.61 shows elements of the extended address (XAD) data type.

**Table E.61 – XAD**

| Name | Usage | DT | Comment |
|---|---|---|---|
| Street Address | R | SAD | Street address<br>Example:<br>"100 Main St." |
| Other Designation | O | ST | Second line of address. |
| City | R | ST | City element of address<br>Example:<br>"Raleigh" |
| State or Province | R | ST | State or province element of address<br>Example:<br>"NC" or "North Carolina" |
| Zip or Postal Code | R | ST | Postal code element of address<br>Example:<br>"27613" |
| Country | O | ID | Country element of address |
| Address Type | R | ID | Code that denotes the type of address. PCD-01 requires this value to be "M" to indicate "mailing address" |
| Other Geographic Designation | O | ID | Code to denote any other designation. Not typically used for services interface |
| County/Parish Code | O | IS | Code to denote the county address is within. Not typically used for services interface |
| Census Tract | O | IS | Code to denote the census tract address is within. Not typically used for services interface |
| Address Representation Code | O | ID | Code to denote the representation code. Not typically used for services interface |
| Address Validity Range | X | DR | Never used |
| Effective Date | O | DTM | Start date of address validity. Not typically used for services interface |
| Expiration Date | O | DTM | Stop date of address validity. Not typically used for services interface |

**Table E.61 – XAD**

| Name | Usage | DT | Comment |
|---|---|---|---|
| Expiration Reason | O | CWE | Reason code to denote why address validity has ended. Not typically used for services interface |
| Temporary Indicator | O | ID | Code that denotes whether address is temporary. Not typically used for services interface |
| Bad Address Indicator | O | ID | Code to denote whether address is bad. Not typically used for services interface |
| Address Usage | O | ID | Code to denote intention of address usage. Not typically used for services interface |
| Addressee | O | ST | Element identifies the "Care of" or "C/O" line of address. Not typically used for services interface |
| Comment | O | ST | Arbitrary description text. Not typically used for services interface |
| Preference Order | O | NM | Defines order of preference when multiple addresses are given. Not typically used for services interface |
| Protection Code | O | CWE | Code to denote any special sensitivity in handling of address. Not typically used for services interface |
| Address Identifier | O | EI | Unique identifier to enable a linking of address to multiple people. Not typically used for services interface. |

### E.5.6.1 Examples

```
123 Main St.^^Raleigh^North Carolina^27613^M
```

### E.5.7 XPN

The specifications in this clause are derived from the IHE PCD Technical Framework [IHE PCD-TF-2], Appendix C.

Table E.62 shows the core data in the extended person name (XPN) data type.

**Table E.62 – XPN**

| Name | Usage | DT | Comment |
|---|---|---|---|
| Family Name | RE | FN | Family or last name. According to [IHE PCD-01] this entry is required if known to the sender. Not clear how that is testable. |
| Given Name | RE | ST | First name |
| Second and Further Given Names or Initials | RE | ST | Middle name(s) separated by spaces |
| Suffix | RE | ST | Suffix e.g., Jr. or III |
| Prefix | RE | ST | Prefix e.g., Dr. |
| Degree | X | IS | Never used |
| Name Type Code | R | ID | Code to indicate type of name. Common codes would be "L" for legal name or "A" for alias name |
| Name Representation Code | RE | ID | Code to indicate representation codes. The most common code would be "A" for alphabetic. |

**Table E.62 – XPN**

| Name | Usage | DT | Comment |
|---|---|---|---|
| Name Context | RE | CWE | Context in which name is used. Not typically used for Services interface |
| Name Validity Range | X | DR | Never used |
| Name Assembly Order | RE | ID | Code to indicate display order. Not typically used for services interface |
| Effective Date | RE | DTM | Start date of the name's validity. Not typically used for services interface |
| Expiration Date | RE | DTM | End date of the name's validity. Not typically used for services interface |
| Professional Suffix | RE | ST | Specifies abbreviation(s) denoting professional qualifications. Not typically used for services interface |

### E.5.7.1 Examples

```
Clemens^Samuel^Langhorne^^^^L
Twain^Mark^^^^^A
```

## E.6 Other HL7 data types

The specifications in this clause are derived from the IHE PCD Technical Framework Volume 2, Revision 2.0 [IHE PCD TF 2012 2].

This clause contains the definition of a number of common data types used in the PCD-01 transaction, but are not used as observations. Please see [IHE PCD-01] or [HL7 v2.6] for a complete list of data types.

### E.6.1 CX

Table E.63 shows details of the HL7 CX data type.

**Table E.63 – CX**

| Name | Usage | DT | Comment |
|---|---|---|---|
| ID Number | R | ST | The value of the identifier |
| Check Digit | RE | ST | Check digit. Not typically used for services interface |
| Check Digit Scheme | RE | ID | Code to indicate how check digit was calculated. Not typically used for services interface |
| Assigning Authority | R | HD | Unique name of the system/organization that creates the data. |
| Identifier Type Code | RE | ID | A code to indicate the scheme for the identifier. A very common type code is "PI" which indicates it is a Patient Internal Identifier or a code unique to the organization |
| Assigning Facility | RE | HD | Place where identifier was first assigned. Not typically used for services interface |
| Effective Date | RE | DT | Date for identifier validity to start. Not typically used for services interface |
| Expiration Date | RE | DT | Date for identifier validity to end. Not typically used for services interface |
| Assigning | RE | CWE | Geo-political body that assigned identifier. Not typically |

**Table E.63 – CX**

| Name | Usage | DT | Comment |
|---|---|---|---|
| Jurisdiction | | | used for services interface |
| Assigning Agency or Department | RE | CWE | Agency or department that assigned identifier. Not typically used for services interface |

### E.6.1.1 Examples

```
789567^^^Imaginary Hospital^PI
P12345^^^Imaginary Hospital
```

### E.6.1.2 EI

The specifications in this clause are derived from Appendix C in the IHE PCD Technical Framework Volume 2, Revision 2.0 [IHE PCD TF 2012 2].

Table E.64 shows the core data in an entity identifier.

**Table E.64 – Entity identifier**

| Name | Usage | DT | Comment |
|---|---|---|---|
| Entity Identifier | R | ST | Always required. PCD-01 constrains this to be 16 characters unless extended due to national extensions |
| Namespace ID | RE | IS | May be used without components 3 and 4 |
| Universal ID | ST | ID | May be used in conjunction with component 4 but without component 2 |
| Universal ID Type | RE | ID | May be used in conjunction with component 3 but without component 2. EUI-64 is a universal ID type. |

The important issue with this data type is whether or not one is using a universal ID type or Namespace ID. A Universal ID Type would be a EUI-64 such as a system id. A time base might be a case where a Namespace ID would be used. The distinction has caused confusion in versions prior to DG2015.

### E.6.1.3 Examples

```
0123456789ABCDEF^^0123456789ABCDEF^EUI-64 (universal id case)
AB12345^RiversideHospital (local id case)
BT_ABCDEF123456_01^TIMEBASE_ID (local id case)
AB12345^^1.2.840.45.67^ISO (universal id case)
AB12345^RiversideHospital^1.2.840.45.67^ISO (universal id case)
```

## E.6.2 ID coded value for HL7 defined tables

The specifications in this clause are derived from the [HL7 v2.6], clause 2.A on data types.

Table E.65 shows the core data in a HL7 Component table for ID string datacoded value for HL7 defined tables.

**Table E.65 – HL7 Component table – ID string datacoded value for HL7 defined tables**

| SEQ | LEN | DT | OPT | TBL# | COMPONENT NAME | COMMENTS | SEC.REF. |
|---|---|---|---|---|---|---|---|
| | | | | | Coded value for HL7-defined tables | | |

**Maximum length:** Varies dependent on length of longest code in code set.

The value of such a field follows the formatting rules for an ST field except that it is drawn from a table of legal values. There shall be an HL7 table number associated with ID data types. An example of an ID field is OBR-25-result status. This data type should be used only for HL7 tables (see clause 2.5.3.6 "Table" in [HL7 2.6]). The reverse is not true, since in some circumstances it is more appropriate to use the CNE or CWE data type for HL7 tables.

### E.6.3 IS coded value for user-defined tables

The specifications in this clause are derived from the [HL7 v2.6], clause 2.A on data types.

Table E.66 shows the core data in a HL7 component table for IS coded value for user-defined tables string data.

**Table E.66 – HL7 component table – IS coded value for user-defined tables string data**

| SEQ | LEN | DT | OPT | TBL# | COMPONENT NAME | COMMENTS | SEC.REF. |
|---|---|---|---|---|---|---|---|
| | 20 | | | | Coded Value for User-Defined Tables | | |

**Maximum length: 20**

The value of such a field follows the formatting rules for an ST field except that it is drawn from a site-defined (or user-defined) table of legal values. There shall be an HL7 table number associated with IS data types. An example of an IS field is the Degree field defined in the XPN data type. This data type should be used only for user-defined tables. What this means is that IS data types are always parts of another data type and do not appear as stand-alone field entries. The reverse is not true, since in some circumstances, it is more appropriate to use the CWE data type for user-defined tables instead of the IS data type.

### E.6.4 SI sequence ID

The specifications in this clause are derived from the [HL7 v2.6], clause 2.A on data types.

Table E.67 shows the core data in a HL7 Component table for SI sequence ID.

**Table E.67 – HL7 component table – SI sequence ID**

| SEQ | LEN | DT | OPT | TBL# | COMPONENT NAME | COMMENTS | SEC.REF. |
|---|---|---|---|---|---|---|---|
| | 4 | | | | Sequence ID | | |

**Definition:** A non-negative integer in the form of a NM field. The uses of this data type are defined in the chapters defining the segments and messages in which it appears.

**Maximum length**: 4. This allows for a number between 0 and 9999 to be specified.

### E.6.5 SN structured numeric

The specifications in this clause are derived from the HL7 v2.6, 2.A Data Types.

Table E.68 shows the core data in a HL7 Component table for a SN structured numeric data type.

**Table E.68 – HL7 component table – SN structured numeric**

| SEQ | LEN | DT | OPT | TBL# | COMPONENT NAME | COMMENTS | SEC.REF. |
|---|---|---|---|---|---|---|---|
| 1 | 2 | ST | O | | Comparator | | |
| 2 | 15 | NM | O | | Num1 | | |
| 3 | 1 | ST | O | | Separator/Suffix | | |
| 4 | 15 | NM | O | | Num2 | | |

**Definition**: The structured numeric data type is used to unambiguously express numeric clinical results along with qualifications. This enables receiving systems to store the components separately, and facilitates the use of numeric database queries. The corresponding sets of values indicated with the <comparator> and <separator/suffix> components are intended to be the authoritative and complete set of values. If additional values are needed for the <comparator> and <separator/suffix> components, they should be submitted to HL7 for inclusion in the Standard.

If <num1> and <num2> are both non-null, then the separator/suffix must be non-null. If the separator is "−", the data range is inclusive; e.g., <num1> − <num2> defines a range of numbers x, so that:<num1> <=x<= <num2>.

**Maximum length**: 36

### E.6.5.1 Comparator (ST)

Defined as greater than, less than, greater than or equal, less than or equal, equal, and not equal, respectively (= ">" or "<" or ">=" or "<=" or "=" or "<>"

If this component is not valued, it defaults to equal ("=").

### E.6.5.2 Num1 (NM)

A number.

### E.6.5.3 Separator/Suffix (ST)

"−" or "+" or "/" or "." or ":"

### E.6.5.4 Examples

```
|>^100|   (greater than 100)
|^100^-^200|   (equal to range of 100 through 200)
|^1^:^228|     (ratio of 1 to 128, e.g., the results of a serological test)
|^2^+|    (categorical response, e.g., occult blood positivity)
```

### E.6.5.5 Num2 (NM)

A number or null depending on the measurement.

### E.6.6 XTN

The specifications in this clause are derived from the IHE PCD Technical Framework Volume 2, Revision 2.0 [IHE PCD TF 2012 2].

Table E.69 shows the details for the XTN data type.

**Table E.69 – XTN**

| Name | Usage | DT | Comment |
|---|---|---|---|
| Telephone Number | X | ST | |
| Telecommunication Use Code | R | ID | Code to denote the use of the number.<br>PCD-01 constrains this value to be either "PRN" for primary residence number or "NET" for network/email address |
| Telecommunication Equipment Type | R | ID | Code to denote equipment type.<br>PCD-01 constrains this value to be either<br>"PH" for telephone when XTN.2 is "PRN" or<br>"Internet" for internet address when XTN.2 is "NET" or<br>"X.400" for X.400 email address when XTN.2 is "NET" |
| Communication Address | RE | ST | When valued this would contain the email address |
| Country Code | RE | NM | Contains the telephone country code |
| Area/City Code | RE | NM | Contains the telephone area/city code |
| Local Number | RE | NM | Contains the core phone number |
| Extension | RE | NM | Contains the contact extension |
| Any Text | RE | ST | Arbitrary comment text to accompany the phone number.<br>Example:<br>"do not call on weekends" |
| Extension Prefix | RE | ST | Contains codes used to establish call with a company's internal phone system |
| Speed Dial Code | X | ST | |
| Unformatted Telephone Number | X | ST | |
| Effective Start Date | O | DTM | Start date of the telecommunication number's validity.<br>Not typically used for services interface |
| Expiration Date | O | DTM | End date of the telecommunication number's validity.<br>Not typically used for services interface |
| Expiration Reason | O | CWE | Code to explain why number's validity ended. Not typically used for services interface |
| Protection Code | O | CWE | Code to indicate sensitivity of the contained number. Not typically used for services interface |
| Shared Telecommunication Identifier | O | EI | This field allows a unique identifier to be assigned to the contained number so that it can be referenced. Not typically used for services interface |
| Preference Order | O | NM | This field indicates the preferred order if there are multiple numbers specified. Not typically used for services interface |

### E.6.6.1 Examples

```
^PRN^PH^^^919^5554321
^NET^Internet^bubba@boguscompany.com
```

## E.7 HL7 control characters

Table E.70 shows the HL7 v2.6 delimiter values.

**Table E.70 – HL7 v2.6 delimiter values**

| Delimiter | Suggested value | Encoding character position | Usage |
|---|---|---|---|
| Segment terminator | <cr> | – | Terminates a segment record. This value cannot be changed by implementers |
| Field separator | \| | – | Separates two adjacent data fields within a segment. It also separates the segment ID from the first data field in each segment |
| Component separator | ^ | 1 | Separates adjacent components of data fields where allowed |
| Repetition separator | ~ | 2 | Separates multiple occurrences of a field where allowed |
| Escape character | \ | 3 | Escape character for use with any field represented by an ST, TX or FT data type, or for use with the data (fourth) component of the ED data type. If no escape characters are used in a message, this character may be omitted. However, it must be present if subcomponents are used in the message.<br>Best practice is to always include this character.<br>For the Continua services transaction, this entry **shall** always be present in MSH-2. |
| Subcomponent separator | & | 4 | Separates adjacent subcomponents of data fields where allowed. If there are no subcomponents, this character may be omitted. Best practice is to always include this character<br>For the Continua services transaction, this entry **shall** always be present in MSH-2. |

# Bibliography

For a list of non-normative references and publications that contain further background information, see [ITU-T H.810].

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