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PERSONAL HEALTH DEVICES TRANSCODING WHITE PAPER

ABSTRACT: This document is informative. It aims to facilitate the task of implementing a transcoder from GATT based specifications designed for *Bluetooth*® devices to a format compatible with IEEE 11073-20601. It provides recommendations and examples describing how a transcoding process can be done.

Revision History		
Revision	**Date**	**Description**
V10r00	10 May 2011	Approved by the Bluetooth SIG Board of Directors.
V11r00	25 October 2011	Incorporated Heart Rate transcoding section 3.2. Incorporated fixes and clarifications throughout document based on feedback. Approved by the Bluetooth SIG Board of Directors.
V12r00	15 November 2011	Added Blood Pressure transcoding section 3.3. Minor editorial and formatting fixes in other sections. Incorporated fixes and clarifications based on feedback. Approved by the Bluetooth SIG Board of Directors.
V13r00	31 May 2012	Added Glucose Meter transcoding section 3.4. Changed Thermometer transcoding section 3.1.2. Added Metric-Id to identify thermometer location. Changed section 2.2.4, item Date-and-Time. Incorporated fixes and clarifications based on feedback.
V14r00	30 Apr 2013	Added section 3.2.2.3: transcoding of Energy Expended for Heart Rate. Incorporated fixes and clarifications based on feedback from Lamprey Networks and others. Incorporated feedback from BARB. Approved by the Bluetooth SIG Board of Directors.
V15r00	21 October 2014	Added Section 3.5 related to the Weight Scale specification with the Body Composition option. Generalized text to enable use with GATT-based devices using the BR/EDR transport and not just those using the Bluetooth low energy transport. Added text related to Base-Offset-Time characteristic. Phased out recommendations related to the use of the Date Time characteristic in favor of the use of Current Time Service v1.1. Incorporated several fixes and clarifications throughout based on feedback from Continua. Approved by the Bluetooth SIG Board of Directors.

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Contents

1. Overview

This document describes how data sent by a Bluetooth Sensor based on GATT (Generic Attribute Profile) and received by a Collector can be transcoded at the Collector into an IEEE Std. 11073-20601a [1] compatible nomenclature and model, thus enabling compatibility with the ISO/IEEE Std. 11073-104xx family of standards (both hereafter known as 11073-20601).

Services and Profiles for Bluetooth implementations have been developed using the GATT-based Profile architecture designed to support low power and low cost device implementation. Data values used in these Profiles are defined as characteristics associated with a UUID accessible via the Bluetooth SIG Assigned Numbers [3].

This document covers how characteristic values can be mapped or transcoded in a consistent way to 11073-20601 nomenclature/object/attribute equivalents. This data compatibility will enable data from GATT-based Bluetooth devices to be used in the broader health ecosystem such that the transcoded measurement data will look the same as data from a Bluetooth Health Device Profile device or a USB Personal Healthcare Device Class device.

This data compatibility will enable data to be usable and consumable by a variety of healthcare-related organizations including the Continua Health Alliance and standards organizations related to health records such as HL7. All mandatory (as well as some optional) attributes defined for each specialization in 11073-104xx standards are supported by Bluetooth Profiles defined within this document, but support for optional attributes is not specifically required for data compatibility.

For the Profiles encompassed by the material in this document, all characteristics and fields that are relevant to 11073-20601 have been defined with the intent that they can be transcoded at the Collector without any loss of precision.

In order to enable such a process for a particular device, the Collector device implementing transcoding software is required to follow the general requirements in Section 2 and the device-specific requirements in Section 3. Section 3 will be expanded as new health-related Bluetooth Profiles become available. Section 4 provides an end-to-end example describing how data can be mapped from a GATT-based Health Thermometer [5] to a Collector implementing a Transcoder.

While it is beyond the scope of this document to mandate or specify a specific *method* for transcoding Bluetooth characteristics into 11073-20601, this white paper provides requirements and guidelines to enable implementations to do so. This document does not discuss 11073-20601 concepts and details; rather, it focuses on how data from Bluetooth sensors can be transcoded for use in the 11073-20601 domain.

Although some areas of this document summarize requirements of 11073-20601 and 11073-104xx documents as a useful reference, refer to the 11073-20601 and 11073-104xx standards to ensure the most accurate information regarding 11073-20601 specifications' requirements. Similarly, refer to the relevant Bluetooth Profile specifications with their associated Service specifications and characteristic(s) as the official sources for Bluetooth-related requirements.

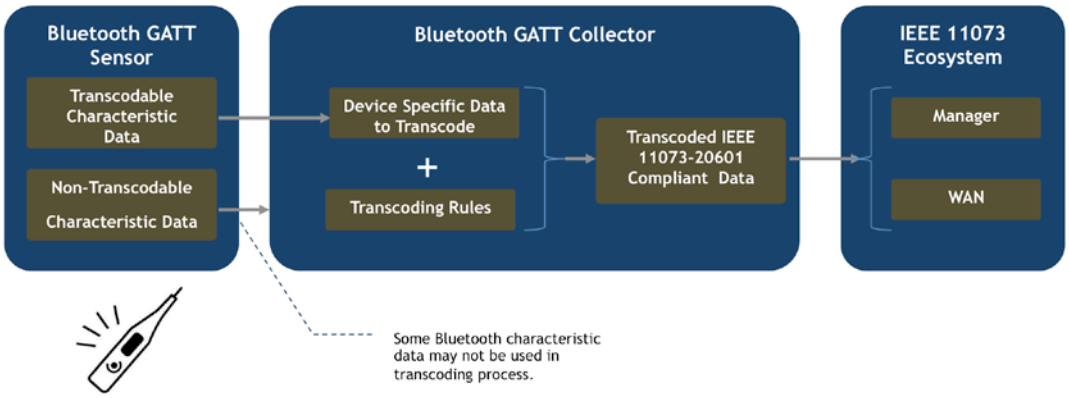

Figure 1: GATT-based Bluetooth Sensor to 11073-20601 Data Flow

The 11073-20601 DIM (Domain Information Model) of any given device type is typically more complex than, and completely different from, the related Bluetooth GATT-based health Service. This document specifies how to transcode data from GATT-based Services to DIM and nomenclature, but it is important to recognize that Collector devices are **not** actually required to create the DIM, with all its objects, attributes, or APDUs (Application Protocol Data Units, i.e. network packets) associated with 11073-20601 transactions.

The purpose of the transcoded DIMs and nomenclatures described in this white paper is just to provide a mapping. In the end, if the Collector wishes to forward data over any additional interfaces (e.g. IHE-PCD-01 [17] documents) requiring 11073-20601 nomenclature, it must do so *as if* the data had come from the DIMs as described in this white paper.

There are a number of objects that may exist in a 11073-20601 DIM that have the purpose to aid in providing more efficient transfer of data from the Sensor (Agent) device to the Collector (Manager). Scanner and PM-Store are examples of such objects. They do not affect the value and meaning of data measurements. This paper will not describe these kinds of objects and their use is at implementation's discretion.

In addition, all 11073-20601 APDUs are only of interest for 11073-20601 formatted exchanges. Transcoding the sensor device down to the APDU level, simulating a complete 11073-20601 Agent that exchanges APDUs with a 11073-20601 Manager/Collector is a valid transcoding strategy. But is not the only strategy, and it is not mandated by this paper. Any simulation of APDU transcoding is outside the purpose of this paper and is left up to the implementation.

Likewise, this paper will restrict itself to the description of those components of the DIM and nomenclature that are used to describe the *measurements* and the *device*. All additional components of the DIM are outside the purpose of this paper and are left up to the implementation.

2. General Data Requirements

This section describes the transcoding of general data from a Bluetooth Sensor for compatibility with the 11073-20601 ecosystem, and general data mapping requirements that are common to all devices addressed by this white paper. Device-specific data requirements are described in Section 3.

2.1 COMMON MDS CLASS REQUIREMENTS

This sub-section describes general Medical Device System (MDS) class requirements from 11073-20601. The MDS is the object that describes the device and its properties. The majority of the data to populate this object's attributes comes from the Device Information Service (DIS) [2] and the Current Time Service (CTS) [14]. 11073-20601 attributes not mentioned in this section likely refer to Bluetooth device-specific data requirements and are shown in Section 3.

The Device Information Service is a general Bluetooth Service designed to describe characteristics that are often common between different sensors. The DIS includes characteristics that contain information such as the manufacturer name, model number, hardware revision, firmware revision, and software revision among others. Many characteristics in the DIS are used within the 11073-20601 and Continua Health Alliance infrastructure.

The Current Time Service provides the Collector with a means of obtaining the current time on the Sensor device. This time is entered into the Date-and-Time attribute of the MDS. The need to know the current time on the Sensor is essential if the Sensor sends measurement characteristics that contain time stamps. Knowing the Sensor's current time allows the Collector to compare its current clock with the Sensor's current clock and determine any differences. This clock information is required for the generation of e.g. HL7 data. If the Sensor provides no time stamps, the Collector uses the time of reception as the time stamp. Such devices do not need a Current Time Service and the transcoded MDS will not have a Date-and-Time attribute.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	None	N/A	N/A	HANDLE[1]	INT-U16
System-Model	Model Number String, Manufacturer Name String	DIS	UTF-8 String, UTF-8 String	SystemModel[2]	(OCTET STRING, OCTET STRING)
System-Id	System ID	DIS	EUI-64	OCTET STRING	OCTET STRING
Dev-Configuration Id	None	N/A	N/A	ConfigId[3]	List of (INT-U16, INT-U16)
Attribute-Value-Map	None	N/A	N/A	AttrValMap[4]	List of (INT-U16, INT-U16)

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Production-Specification	Serial Number String, Hardware Revision String, Software Revision String, Firmware Revision String[5]	DIS	UTF-8 String	ProductionSpec	List of (INT-U16, INT-U16, OCTET STRING)
Date-and-Time	Current Time	Current Time Service[6]	Aggregate	AbsoluteTime	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Mds-Time-Info	None	N/A	N/A	MdsTimeInfo	(BITS-16, INT-U16, INT-U32, INT-U16, INT-U16, INT-U32)
Relative-Time	None	N/A	N/A	RelativeTime	INT-U32
HiRes-Relative-Time	None	N/A	N/A	HighResRelativeTime	OCTET STRING (SIZE(8))
Date-and-Time-Adjustment	None	N/A	N/A	AbsoluteTimeAdjust	OCTET STRING (SIZE(6))
Power-Status	In Development (Future updated Battery Service)	In Development (Future updated Battery Service)	N/A	PowerStatus	BITS-16
Battery-Level	Battery Level	Battery Service	UINT8	INT-U16[7]	INT-U16
Remaining-Battery-Time	None	N/A	N/A	BatMeasure	(FLOAT-Type, INT-U16)
Reg-Cert-Data-List	IEEE 11073-20601 Regulatory Certification Data List	DIS	Aggregate	RegCertDataList	List of ((INT-U8, INT-U8), ANY)
System-Type-Spec-List	None	N/A	N/A	TypeVerList[8]	List of (INT-U16, INT-U16)
Confirm-Timeout[9]	None	N/A	N/A	RelativeTime	OCTET STRING (SIZE(6))

Table 1: Common MDS Class Requirements

Notes:

1. 11073-20601 requires that it is always set to 0.
2. SystemModel is described as SEQUENCE (Manufacturer Name, Model Number).
3. The device configuration id is only of use in 11073-20601 formatted exchanges. Its value is implementation specific.
4. This 11073-20601 attribute is transmission-related only. As this document is only relevant for nomenclature and model compatibility and does not mandate any way to reach the 11073-20601 domain, this attribute is implementation specific.
5. Each field is mapped into a unique entry of ProductionSpec list; for example, Serial Number String is mapped as (0x0001, INT-U16, serial_number_value). See Section 2.2.4.
6. This attribute is necessary and readable when the device timestamps measurements. See item 2.2.4, subtopic “Date and Time”, and item 2.2.6 for details.
7. Both Battery Level characteristic and Battery-Level attribute express battery level as an integer percentage (0 to 100). Characteristic is transcoded simply by promoting value from UINT8 to INT-U16 with no scaling.
8. For each Profile addressed by this white paper and implemented by the device, an entry has to be added to the TypeVerList. For example, if a device implements the Health Thermometer Service [5], the following entry is required by 11073-20601 to be added to the TypeVerList:

   0x10 0x08 type = MDC_DEV_SPEC_PROFILE_TEMP
   0x00 0x01 version = version 1 of the specialization

9. The ConfirmTimeout is only for use in 11073-20601 formatted exchanges. It tells the Manager how long the Agent will wait for a confirmation to a confirmed event report before timing out. Its value is implementation specific.

2.2 TRANSCODING BLUETOOTH CHARACTERISTICS TO 11073-20601 ATTRIBUTES

2.2.1 32-BIT FLOATING POINT DATA TYPE (FLOAT-TYPE)

The following information is defined in ISO/IEEE Std. 11073-20601™-2008 [1].

The FLOAT-Type data type is defined to represent numeric values that are not integer in type. The FLOAT-Type is defined as a 32-bit value with a 24-bit mantissa and an 8-bit exponent. See Annex F.6 of [1] for a thorough definition of the FLOAT-Type. This data type is defined as follows:

	Exponent	**Mantissa**
Size	1 octet	3 octets

The 32 bits contain an 8-bit signed exponent to base 10, followed by a 24-bit signed integer (mantissa).

Special values are assigned to express the following:

- + INFINITY [exponent 0, mantissa +(2^23 –2) → 0x007FFFFE]
- NaN (Not a Number) [exponent 0, mantissa +(2^23 –1) → 0x007FFFFF]
- NRes (Not at this Resolution) [exponent 0, mantissa –(2^23) → 0x00800000]
- Reserved for future use [exponent 0, mantissa –(2^23–1) → 0x00800001]
- – INFINITY [exponent 0, mantissa –(2^23 –2) → 0x00800002]

NaN is used to report an invalid result from a computation step or to indicate missing data due to the hardware’s inability to provide a valid measurement, perhaps from sensor disturbances.

NRes is used to report that the value cannot be represented with the available range and resolution, possibly resulting from an overflow or underflow situation.

Example

Example for temperature measurement in 11073-20601 FLOAT-Type format:

Consider a temperature measurement of 36.4 **degrees** Celsius with precision of 0.1 **degrees** Celsius. The FLOAT-Type representation is a 32-bit value consisting of an exponent of an 8-bit signed integer followed by a mantissa of a 24-bit signed integer; here, the exponent is -1 (0xFF) and the mantissa is 364 (0x00016C). Therefore, the FLOAT-Type representation of 36.4 is 0xFF00016C.

2.2.2 16-BIT FLOATING POINT DATA TYPE (SFLOAT-TYPE)

The following information is defined in ISO/IEEE Std. 11073-20601™-2008 [1].

The SFLOAT-Type data type (a shortened version of FLOAT-Type) is defined to represent numeric values that are not integer in type. The SFLOAT-Type is defined as a 16-bit value with 12-bit mantissa and 4-bit exponent. See Annex F.8 of [1] for a thorough definition of the SFLOAT-Type. This data type is defined as follows:

	Exponent	**Mantissa**
Size	4 bit	12 bit

The 16–bit value contains a 4-bit exponent to base 10, followed by a 12-bit mantissa. Each is in twos-complement form.

Special values are assigned to express the following:

- NaN (Not a Number) [exponent 0, mantissa +(2^11 –1) → 0x07FF]
- NRes (Not at this Resolution) [exponent 0, mantissa –(2^11) → 0x0800]
- + INFINITY [exponent 0, mantissa +(2^11 –2) → 0x07FE]
- – INFINITY [exponent 0, mantissa –(2^11 –2) → 0x0802]
- Reserved for future use [exponent 0, mantissa –(2^11 –1) → 0x0801]

Example

Example for blood pressure measurement in 11073-20601 SFLOAT-Type format:

Consider a systolic blood pressure measurement of 114 mmHg with a precision of 1 mmHg. The SFLOAT-Type representation is a 16-bit value consisting of an exponent of a 4-bit signed integer followed by a mantissa of a12-bit signed integer; here, the exponent is 0 (0x0) and the mantissa is 114 (0x072). Therefore, the SFLOAT-Type representation of 114 is 0x0072.

2.2.3 STRING CONVERSION

11073-20601 variable-length string type is encoded with a field length of 2 octets followed by the specific OCTET STRING data array. 11073-20601 strings must be even length (16-bit aligned). For optimized data exchange over GATT, no such requirement exists. Bluetooth characteristic strings can be odd or even length, and the length of the string can be deciphered from the data. To transcode an odd length string, append a zero (0x00) byte to the end of the string, and increment the string length field.

Bluetooth characteristic strings are encoded as UTF-8, whereas 11073-20601 strings are encoded as ASCII printable characters (a UTF-8 subset). The transcoder shall convert non-ASCII characters in characteristic strings to ASCII in order to satisfy 11073-20601 standards. The converted string may have a different length than the original UTF-8 string. The choice of conversion strategy is left to the implementation.

If the transcoder implementation chooses to transcode health device data directly from Bluetooth GATT string format to a higher-level protocol (e.g. PCD-01) that supports UTF-8, no string conversion is necessary.

2.2.4 MDS ATTRIBUTE CONVERSION

System-Model

The System-Model 11073-20601 attribute consists of a sequence that contains manufacturer name and model number, respectively. Its content is vendor-decided, and represented as an OCTET STRING. Therefore, it must follow the string conversion rules as described in Section 2.2.3.

All fields of the System-Model attribute are derived from the characteristics in the DIS [2]. The Bluetooth "Manufacturer Name String" and "Model Number String" characteristics of the DIS map to the Manufacturer Name and Model Number field of the System Model 11073-20601 Attribute.

System-Id

The System-Id 11073-20601 attribute has the same constraints as defined by the "System ID" Bluetooth characteristic (an EUI-64, which consists of a 24-bit Organizationally Unique Identifier followed by a 40-bit manufacturer-defined identifier). It is mapped directly from the DIS "System ID" Bluetooth characteristic value. For more information, see the DIS [2].

Production-Specification

The 11073-20601 attribute consists of a ProdSpecEntry list. Each entry may describe specific information such as serial number, hardware revision, software revision, protocol revision, firmware revision, and part numbers. Additionally, each entry in the list contains a Spec Type defining which type of specification it refers to, a vendor-specified component ID, and a vendor-specified ASCII printable string, mapped directly from the DIS characteristics as follows.

ProdSpecEntry Spec Type	Bluetooth characteristic	11073-20601 Spec Type Value
Unspecified	N/A	0x0000
Serial Number	Serial Number String (DIS)	0x0001
Part Number	N/A	0x0002
Hardware Revision	Hardware Revision String (DIS)	0x0003
Software Revision	Software Revision String (DIS)	0x0004
Firmware Revision	Firmware Revision String (DIS)	0x0005
Protocol Revision	N/A	0x0006
GMDN (Global Medical Device Nomenclature)	N/A	0x0007

Table 2: Production Specification

The conversion is done as follows for each Bluetooth characteristic (Serial Number String, Hardware Revision String, Software Revision String, and Firmware Revision String):

1. Create a new ProdSpecEntry.
2. Set the first field (spec_type) according to table above.
3. Set the second field to the vendor-specified component ID.
4. Set the third field to the corresponding Bluetooth characteristic value.

Date-and-Time

The transcoder shall provide this attribute if measurements report timestamps in any message (ref: [1] Section 6.3.2.3). The attribute represents the current time in Sensor's clock.

If the Sensor reports a timestamp in any message, the Sensor implementation should support the Current Time Service [14]. The 10-byte Current Time characteristic value is transcoded to the 8-byte Date-and-Time attribute value as specified in Section 2.2.6 and the 1-byte Day of Week and Adjust Reason fields are not part of the Date-and-Time attribute. Note that starting in v1.5 of the white paper, text in this section related to exposing the Date Time characteristic (first added in v1.3) has been removed and

replaced with a recommendation to use CTS v1.1. This is due to the recent release of CTS v1.1 which added useful features and resolved limitations in CTS v1.0.

Since the Current Time characteristic uses absolute time, an issue may arise in cases where measurement results are time stamped with absolute time or separate base time and time offset fields. If the time is changed on the Sensor after the last measurement is stored in the Sensor's memory and before the Collector reads the current time from the Sensor, then the measurement results will not be on the same absolute time base as the Sensor's current time. This may cause the Collector to incorrectly synchronize the prior measurement results to the Collector's time base.

The value of 'unknown' is not permitted for year, month or day, as valid values are required for transcoding. If 'unknown' values are observed, the information shall be discarded, and handled as nonexistent.

2.2.5 IEEE 11073-20601 REGULATORY CERTIFICATION DATA LIST

Health and Medical Devices may claim adherence to various regulatory and/or certification compliance items as an informative statement.

The IEEE 11073-20601 Regulatory Certification Data List [16] enables a device to list the compliance items identifying the authorizing body and its data. IEEE, Continua, and the FDA are a few examples of authorizing bodies.

The IEEE 11073-20601 Regulatory Certification Data List is defined as an opaque structure (a "blob") in the DIS by a regulatory body. The endianness of this data structure is as defined in the associated regulatory specification. For example, if the regulatory body is Continua, the "RegCertDataList" data structure will be in big-endian format.

Following is an example of this structure based on Continua Design Guidelines 2015 (v5.0) [6].

In this example, the *IEEE 11073-20601 Regulatory Certification Data List* characteristic is required to have the following format:

Field Name	Offset	Size	Data Type	Definition / Notes
Regulatory Certification Data List	0			
Count	0	2 octet	INT-U16	
Length	2	2 octet	INT-U16	
Authorization Body	4	1 octet	INT-U8	Code assigned by IEEE 11073-20601 identifying the authorizing body
Authorization Body Structure Type	5	1 octet	INT-U8	Identifies the data structure
Authorization Body Structure Length	6	2 octet	INT-U16	Defines authorization body data length
Authorizing Body Data	8	variable length	Opaque structure	Format defined by Authorizing Body (Continua)
Major IG version	8	1 octet	INT-U8	
Minor IG version	9	1 octet	INT-U8	
Certified device class list	10			
Count (c)	10	2 octet	INT-U16	Number of device classes
Length	12	2 octet	INT-U16	c * sizeof(INT-U16)
Certified device class entry	12+n*2	2 octet	INT-U16	May be several of these entries (i.e., c > 1), where *n* is the index of device entry [1..c].
Continua Regulatory Structure	14+c*2	2 octet	INT-U16	
Structure length	16+c*2	2 octet	INT-U16	
Regulation Bit Field Type	18+c*2	2 octet	BITS-16	

Table 3: Format Example for IEEE 11073-20601 Regulatory Certification Data List characteristic

Regulatory Certification Data List and *Certified device class list* are types based on SEQUENCE OF, which specifies a list header with both *count* and *length*, even when the entry size is perfectly known. This allows for robust decoding, allowing the decoder to skip the sequence when it does not know the entry type.

Table 4 is an example showing the contents of this structure based on Continua Design Guidelines 2010 (v1.5) [6]. The minor and major Interoperability Guidelines (IG) version represents the current Continua Guideline being followed, and will be updated as new guidelines are adopted and followed by this document.

In this example, the Continua Health Alliance is the regulatory body and the device includes only one device specialization – the IEEE 11073-10408 Thermometer device specialization [3]. As a result, the *IEEE 11073-20601 Regulatory Certification Data List* characteristic is required to have the following format and values:

Data	Description
0x00 0x02	RegCertDataList.count = 2
0x00 0x12	RegCertDataList.length = 18
0x02 0x01	RegCertDataList{0} auth-body = auth-body-continua = 2 RegCertDataList{0}.auth-body-struc-type = continua-version-struct = 1 (*ContinuaBodyStruct*)
0x00 0x08	RegCertDataList{0}. auth-body-data.length = 8
0x01 0x05	RegCertDataList{0}. auth-body-data: ContinuaBodyStruct.major-IG-version = 5 ContinuaBodyStruct.minor-IG-version = 0
0x00 0x01	CertifiedDeviceClassList.count = 1
0x00 0x02	CertifiedDeviceClassList.length = 2
0x80 0x08	CertifiedDeviceClassList{0} = 0x8008 Based on Continua 2010 (v1.5) guidelines for a Low Power Wireless PAN Thermometer:Transport Code (TCode) = 4 (Low Power Wireless PAN) MDC_DEV_SPEC_PROFILE_TEMP = 0x10 0x08 = 4104_{10} CertifiedDeviceClass = 4104-4096+4*8192 = 32776_{10} -> 0x8008
0x02 0x02	RegCertDataList{1} auth-body = auth-body-continua = 2 RegCertDataList{1}.auth-body-struc-type = continua-reg-struct = 2 (*ContinuaRegStruct*)
0x00 0x02	RegCertDataList{1}. auth-body-data.length = 2
0x00 0x00	This is a regulated device

Table 4: IEEE 11073-20601 Regulatory Certification Data List Characteristic Example

In this example, the total length of the structure is 22 octets.

2.2.6 TRANSCODING TIME STAMPS AND CURRENT TIME TO IEEE 11073-20601 ABSOLUTETIME

For the Bluetooth Profiles addressed by this white paper, the measurement time stamps follow the format of the Bluetooth Date Time characteristic. This format is encoded according to the Date Time characteristic definition accessible via the Bluetooth SIG Assigned Numbers [3]. Each field is an 8-bit integer, except for “year”, which is a 16-bit integer.

For example, the time stamp for 18th December 2010, 15:23:06 is encoded as the following 7-byte sequence in the Date Time field: 0xDA 0x07 0x0C 0x12 0x0F 0x17 0x06. Note that due to the little-endian order, the first two bytes in the sequence represent the year.

The Sensor’s current time is exposed by Current Time characteristic in Current Time Service. The format is accessible via the Bluetooth SIG Assigned Numbers [3]. The Current Time characteristic has 10 bytes; the first 7 bytes are in Date Time format, and the ninth byte exposes fractions of a second, in units of 1/256th of a second. The eighth byte (day of week) and tenth byte (adjust reason) are not taken into consideration for transcoding at this time.

For example, the Sensor’s clock for 18th December 2010, 15:23:06.750 is encoded as the following 10-byte sequence in the Current Time field: 0xDA 0x07 0x0C 0X12 0X0F 0x17 0x06 0xXX 0xC0 0xXX.

IEEE 11073-20601 AbsoluteTime specifies time with a resolution of 1/100 of a second. Its data format is encoded using binary coded decimal (i.e., 4-bit nibbles) and every field has 8 bits. For example, the date/time 18th December 2010, 15:23:06:75 is encoded as 0x20 0x10 0x12 0x18 0x15 0x23 0x06 0x75.

Bluetooth Date Time characteristic format has a resolution of one second, so, when it is used for timestamps as a standalone format, the sec-fractions field must be set to zero in the transcoding process.

On the other hand, the Current Time characteristic format has a resolution of 1/256 of a second, so the sec-fractions field should be converted in the transcoding process.

Because AbsoluteTime is encoded as a Binary Coded Decimal (BCD) format, a conversion between formats is needed; however, the BCD conversion does not result in a loss of precision.

Table 5 shows mapping from the Bluetooth Time Stamp fields to the AbsoluteTime type fields:

Bluetooth **Field Name (Date Time or Current Time)**	**AbsoluteTime Field Name**
Year	century[1]
	year[2]
Month	month
Day	day
Hours	hour
Minutes	minute
Seconds	second
Fractions256 (only for Current Time)	sec-fractions[3]

Table 5: Bluetooth Date Time characteristic format to IEEE 11073-20601 AbsoluteTime Conversion

Notes:

1. This field is set to the two most significant decimal digits of the Bluetooth Year field, when the value of the Bluetooth Year field is expressed as a 4-digit decimal value.
2. This field is set to the two least significant decimal digits of the Bluetooth Year field, when the value of the Bluetooth Year field is expressed as a 4-digit decimal value.
3. This field is transcoded by multiplying the Fractions256 value by 0.390625 (100/256), rounding down the result to the nearest integer, and then converted to BCD.

2.3 ATTRIBUTE-VALUE-MAP

Each Metric object and the MDS have a conditional Attribute-Value-Map attribute. It is mandatory if the Agent uses fixed-format data update messages. Fixed-format event reports refer to those attributes.

As this document is only relevant for nomenclature and model compatibility and does not mandate any way to reach the 11073-20601 domain, this attribute is implementation-specific.

2.4 PM STORES, SCANNERS, AND PM SEGMENTS

This set of objects and their attributes are only concerned with the 11073-20601 transfer of data.

As this document is only relevant for nomenclature and model compatibility and does not mandate any way to reach the 11073-20601 domain, the creation and use of these objects and their respective attributes is implementation-specific.

3.Device Specific Data Requirements

This section describes the mapping of device specific data from a Bluetooth environment to an 11073-20601 environment. This section will be expanded for various Bluetooth Profiles and Services in the future as they become available.

The table below shows the transport(s) supported by each GATT-based service referenced in this document.

GATT Based Specification	Supported Over Bluetooth LE	Supported Over Bluetooth BR/EDR
Health Thermometer Service v1.0	Yes	Not in this version.
Heart Rate Service v1.0	Yes	Not in this version.
Blood Pressure Service v1.0	Yes	Not in this version.
Glucose Service v1.0	Yes	Not in this version.
Weight Scale Service v1.0	Yes	Yes
Body Composition Service v1.0	Yes	Yes
Current Time Service v1.1	Yes	Yes
Device Information Service v1.1	Yes	Yes

Table 6: Transport Support for GATT-based Services

3.1 HEALTH THERMOMETER

This sub-section defines transcoding the thermometer device specific data into IEEE 11073-10408 Thermometer device specialization [3] class attributes.

3.1.1 DEVICE-SPECIFIC MDS CLASS REQUIREMENTS

In addition to the MDS class requirements shown in Section 2.1, Table 7 shows incremental MDS class requirements specific to this device.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
System-Type	N/A	N/A	N/A	TYPE[1]	(INT-U16, INT-U16)
System-Type-Spec-List	N/A	N/A	N/A	TypeVerList[2]	List of (INT-U16, INT-U16)

Table 7: Device-specific MDS Class Requirements

Notes:

1. Value not present since System-Type-Spec-List exists.
2. Since the “Health Thermometer Service“ [5] is a “Primary Service”, an entry is required to be added to the TypeVerList as follows:

   0x10 0x08 type = MDC_DEV_SPEC_PROFILE_TEMP
   0x00 0x01 version = version 1 of the 11073-10408 device specialization

3.1.2 11073-10408 NUMERIC CLASS REQUIREMENTS

This section describes the 11073-10408 numeric class requirements. It is restricted to those 11073-20601 attributes that are used on the Thermometer device.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE[1]	INT-U16
Type	N/A	N/A	N/A	TYPE[2]	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall[3]	BITS-16
Metric-Id	Temperature Measurement	Health Thermometer	Aggregate	OID-Type[4]	INT-U16
Unit-Code	Temperature Type and Temperature Measurement	Health Thermometer	Aggregate	OID-Type[5]	INT-U16
Absolute-Time-Stamp	Temperature Measurement	Health Thermometer	Aggregate	AbsoluteTime[6]	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Simple-Nu-Observed-Value	Temperature Measurement	Health Thermometer	Aggregate	SimpleNuObsValue[7]	FLOAT-Type

Table 8: 11073-10408 Numeric Class Requirements

Notes:

1. Each metric object is required to have a unique non-zero ID assigned by the implementation.
2. Set to {MDC_PART_SCADA, MDC_TEMP_BODY}.
3. When the Measurement Interval characteristic is not present or when it is present and its value is zero (aperiodic mode) then this is set to 0xF040 (mss-avail-intermittent, mss-avail-stored-data, mss-upd-aperiodic, mss-msmt-aperiodic, mss-acc-agent-initiated). When the Measurement Interval characteristic is present and its value is non-zero (periodic mode) this is set to 0x4040 (mss-avail-stored-data, mss- acc-agent-initiated).
4. The value is inferred either based on the non-static Temperature Type field of Temperature Measurement when it is present (presence indicated by bit 2 of Flags field) or the static Temperature Type characteristic. If both are absent, Metric-Id shall be set to MDC_TEMP_BODY.

11073-10408 Temperature Metric-Id code	Bluetooth Temperature Type Description	Bluetooth Value
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

Table 9: Temperature Metric-Id Description Conversion

5. This value is mapped from Bit 0 of the least significant octet of the Temperature Measurement characteristic. The mapping is as follows in Table 10:

11073-10408 Temperature Unit Value	Bluetooth Temperature Unit Value	Temperature Unit Description
MDC_DIM_DEGC	0	Celsius
MDC_DIM_FAHR	1	Fahrenheit

Table 10: Temperature Type Description Conversion

6. When supported, this value is derived from the Time Stamp field of Temperature Measurement characteristic. See Section 2.2.6.
7. This value is derived from the Temperature Measurement Value field of the Temperature Measurement characteristic.

3.2 HEART RATE SENSOR

This section defines transcoding the heart rate Sensor device specific data into IEEE 11073-10406 Basic Electrocardiograph (ECG) device specialization [7] class attributes and the energy expended object of the IEEE 11073-10441 Cardiovascular Fitness and Activity Monitor device specialization [15].

3.2.1 DEVICE-SPECIFIC MDS CLASS REQUIREMENTS

In addition to the MDS class requirements shown in Section 2.1, Table 11 shows incremental MDS class requirements specific to this device.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
System-Type	N/A	N/A	N/A	TYPE[1]	(INT-U16, INT-U16)
System-Type-Spec-List	N/A	N/A	N/A	TypeVerList[3]	List of (INT-U16, INT-U16)
Tick-resolution[2]	N/A	N/A	N/A	FLOAT-Type	FLOAT-Type

Table 11: Device-specific MDS Class Requirements

Notes:

1. Value not present since System-Type-Spec-List exists.
2. Defined as 2^(-10)=1/1024. Matches [8] RR-Interval unit, and can be represented exactly by FLOAT-Type.
3. Since the “Heart Rate Service” [8] is a “Primary Service”, the following entries are required to be added to the TypeVerList (the cardiovascular device specialization may be excluded if the device does not contain the Energy Expended field in the Heart Rate Measurement characteristic; since its absence can only be ascertained when the measurement sequence is completed, in practice its omission would happen if, for example, creating upstream data from the measurement sequence):

0x10 0x06 0x00 0x01	Specialization value = MDC_DEV_SPEC_PROFILE_ECG version = version 1 of the 11073-10406 device specialization
0x10 0x29	Specialization value = MDC_DEV_SPEC_PROFILE_HF_CARDIO
0x00 0x01	version = version 1 of the 11073-10441 device specialization

0x10 0x8D	Profile value = MDC_DEV_SUB_SPEC_PROFILE_HR
0x00 0x01	version = version 1 of the 11073-10406 device specialization

Note that there should be no Date-and-Time attribute since this Service does not support time stamps in its measurements. The Manager shall enter a time stamp at the time of reception of the data.

3.2.2 11073-10406 AND 11073-10441 NUMERIC CLASS REQUIREMENTS

This section describes the 11073-10406 and 11073-10441 numeric class requirements. It is restricted to those 11073-20601 attributes that are used on the Basic Electrocardiograph device and the Cardiovascular Fitness and Activity Monitor device.

3.2.2.1 HEART RATE MEASUREMENT

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE[1]	INT-U16
Type	N/A	N/A	N/A	TYPE[2]	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall[3]	BITS-16
Unit-Code	N/A	N/A	N/A	OID-Type[4]	INT-U16
Simple-Nu-Observed-Value	Heart Rate Measurement (Heart Rate Measurement Value field)	Heart Rate	Aggregate	SimpleNuObs Value[5]	FLOAT-Type

Table 12: 11073-10406 Numeric Class Requirements

Notes:

1. Each metric object is required to have a unique non-zero ID assigned by the implementation.
2. Value is set to {MDC_PART_SCADA | MDC_ECG_HEART_RATE_INSTANT}.
3. Set to 0x4040 (mss-avail-stored-data, mss-acc-agent-initiated).
4. Unit is MDC_DIM_BEAT_PER_MIN.
5. This value is derived from the Heart Rate Measurement Value field of the Heart Rate Measurement characteristic, which is either an 8-bit or 16-bit unsigned integer depending upon bit 0 of the Flags field. This value is converted to FLOAT-Type for transcoding using an exponent of 0.

3.2.2.2 RR-INTERVAL

Optionally transcoded when Heart Rate Measurement contains RR-Interval data.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE[1]	INT-U16
Type	N/A	N/A	N/A	TYPE[2]	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall[3]	BITS-16
Unit-Code	N/A	N/A	N/A	OID-Type[4]	INT-U16
Simple-Nu-Observed-Value	Heart Rate Measurement (RR-Interval field)	Heart Rate	Aggregate	SimpleNuObsValue[5]	FLOAT-Type

Table 13: 11073-10406 Numeric Class Requirements

Notes:

1. Each metric object is required to have a unique non-zero ID assigned by the implementation.
2. Value set to MDC_PART_SCADA | MDC_ECG_TIME_PD_RR_GL.
3. Set to 0x5440 (mss-avail-stored-data, mss-acc-agent-initiated, mss-msmt-btb-metric, mss-msmt-aperiodic).
4. Unit is MDC_DIM_TICK (1/1024s).
5. One or more values are derived from the variable-size RR-Interval field of the Heart Rate Measurement characteristic. In 11073-10406 the sequence of heart rate measurements would occur in independent scan event reports since the event is episodic.

3.2.2.3 ENERGY EXPENDED

Optionally transcoded when Heart Rate Measurement contains Energy Expended field.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE[1]	INT-U16
Type	N/A	N/A	N/A	TYPE[2]	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall[3]	BITS-16
Unit-Code	N/A	N/A	N/A	OID-Type[4]	INT-U16
Simple-Nu-Observed-Value	Heart Rate Measurement (Energy Expended field)	Heart Rate	Aggregate	SimpleNuObsValue[5]	FLOAT-Type

Table 14: 11073-10441 Numeric Class Requirements

Notes:

1. Each metric object is required to have a unique non-zero ID assigned by the implementation.
2. Value set to {MDC_PART_PHD_HF | MDC_HF_ENERGY}.
3. Set to 0xf040 (mss-avail-intermittent, mss-avail-stored-data, mss-updt-aperiodic, mss-msmt-aperiodic, mss-acc-agent-initiated).

4. Unit is MDC_DIM_JOULES.
5. This value is derived from the Energy Expended field of the Heart Rate Measurement characteristic by converting from an unsigned 16-bit integer to a FLOAT using an exponent of 3, and attributing the same numeric value of the field to the mantissa. For example, an Energy Expended of 123 is transcoded to a FLOAT with mantissa=123 and exponent=3. The transcoded value is equal to 123000J, which is equivalent to the original field value of 123kJ. This procedure compensates for the change of unit, without loss of precision.

3.3 BLOOD PRESSURE MONITOR

This section defines transcoding the blood pressure monitor device specific data into IEEE 11073-10407 Blood Pressure Monitor device specialization [10] class attributes.

3.3.1 DEVICE-SPECIFIC MDS CLASS REQUIREMENTS

In addition to the MDS class requirements shown in Section 2.1, Table 15 shows incremental MDS class requirements specific to this device.

11073-20601 Attribute	Bluetooth equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
System-Type	N/A	N/A	N/A	TYPE[1]	(INT-U16, INT-U16)
System-Type-Spec-List	N/A	N/A	N/A	TypeVerList[2]	List of (INT-U16, INT-U16)

Table 15: Device-specific MDS Class Requirements

Notes:

1. Value not present since System-Type-Spec-List exists.
2. Since the “Blood Pressure Service” [9] is a “Primary Service,” the following entries are required to be added to the TypeVerList:

   0x10 0x07 Specialization value = MDC_DEV_SPEC_PROFILE_BP
   0x00 0x01 version = version 1 of the 11073-10407 device specialization

3.3.2 11073-10407 NUMERIC CLASS REQUIREMENTS

This section describes the 11073-10407 numeric class requirements. It is restricted to those 11073-20601 attributes that are used on the Blood Pressure Monitor device.

3.3.2.1 SYSTOLIC/DIASTOLIC/MAP COMPOUND NUMERIC OBJECT (BLOOD PRESSURE)

11073-20601 Attribute	Bluetooth equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE[1]	INT-U16
Type	N/A	N/A	N/A	TYPE[2]	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall[3]	BITS-16
Measurement-Status	Blood Pressure Measurement	Blood Pressure	Aggregate	MeasurementStatus[4]	BITS-16
Metric-Structure-Small	N/A	N/A	N/A	MetricStructure Small[5]	(INT-U8, INT-U8)
Metric-Id-List	N/A	N/A	N/A	MetricIdList[6]	List of (INT-U16)
Unit-Code	Blood Pressure Measurement	Blood Pressure	Aggregate	OID-Type[7]	INT-U16
Absolute-Time-Stamp	Blood Pressure Measurement	Blood Pressure	Aggregate	AbsoluteTime[8]	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Compound-Basic-Nu-Observed-Value	Blood Pressure Measurement	Blood Pressure	Aggregate	Compound-BasicNuObserved Value[9]	List of SFLOAT-Type

Table 16: 11073-10407 Numeric Class Requirements

Notes:

1. Each metric object is required to have a unique non-zero ID assigned by the implementation.
2. Value is set to {MDC_PART_SCADA | MDC_PRESS_BLD_NONINV}.
3. Set to 0xF040 (mss-avail-intermittent | mss-avail-stored-data | mss-upd-aperiodic | mss-msmt-aperiodic | mss-acc-agent-initiated).
4. Omitted if measurement is ok or Measurement Status field is not present; set to 0x4000 (measurement questionable) if any bit of Measurement Status field is set and the Measurement Status feature is supported.

5. Set to (0x03, 0x03) {ms-struct-compound-fix, 3}.
6. List set to {MDC_PRESS_BLD_NONINV_SYS, MDC_PRESS_BLD_NONINV_DIA, MDC_PRESS_BLD_NONINV_MEAN}.
7. This value is mapped from Bit 0 of the least significant octet of the Blood Pressure Measurement characteristic. The mapping is as follows in Table 17:

11073-10407 Pressure Unit Value	Bluetooth Pressure Unit Value	Unit Description
MDC_DIM_MMHG	0	mmHg
MDC_DIM_KILO_PASCAL	1	kPa

Table 17: Pressure Type Description Conversion

8. When supported, this value is derived from the Time Stamp field of Blood Pressure Measurement characteristic. See Section 2.2.6.
9. This is a list of exactly three values derived from Blood Pressure Measurement characteristic: Systolic pressure, Diastolic Pressure and MAP. If any of these measurements are temporarily unavailable, this condition is signaled with NaN special value.

3.3.2.2 PULSE RATE

Optionally transcoded when Blood Pressure Measurement contains Pulse Rate data.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE[1]	INT-U16
Type	N/A	N/A	N/A	TYPE[2]	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall[3]	BITS-16
Measurement-Status	Blood Pressure Measurement (Measurement Status)	Blood Pressure	Aggregate	MeasurementStatus[4]	BITS-16
Unit-Code	N/A	N/A	N/A	OID-Type[5]	INT-U16
Absolute-Time-Stamp	Blood Pressure Measurement (Time Stamp field)	Blood Pressure	Aggregate	AbsoluteTime[6]	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Basic-Nu-Observed-Value	Blood Pressure Measurement (Pulse Rate field)	Blood Pressure	Aggregate	BasicNuObserved Value[7]	SFLOAT-Type

Table 18: 11073-10407 Numeric Class Requirements

Notes:

1. Each metric object is required to have a unique non-zero ID assigned by the implementation.
2. Value set to MDC_PART_SCADA | MDC_PULS_RATE_NON_INV.

3. Set to 0xf040 (mss-avail-intermittent | mss-avail-stored-data | mss-upd-aperiodic | mss-msmt-aperiodic | mss-acc-agent-initiated).
4. Absent if the measurement is good or Measurement Status field is not present; set to 0x4000 (measurement questionable) if any bit of Measurement Status field is set and the Measurement Status feature is supported. The IEEE Measurement-Status attribute is an *observational* attribute and only has meaning for the observation in which it is sent. The absence of the attribute implies a good measurement.
5. Unit is MDC_DIM_BEAT_PER_MIN.
6. When supported, this value is derived from the Time Stamp field of Blood Pressure Measurement characteristic. See Section 2.2.6.
7. This value is derived from Pulse Rate field of Blood Pressure Measurement characteristic, if available.

3.3.2.3 USER ID

The 11073-20601 Person-ID is of type INT-U16, while the User ID from the characteristic is one octet, unsigned. When the User ID is in range 0x00 to 0xFE, conversion shall keep the numeric value. For example, User ID 0x02 would be transcoded to Person-ID 0x0002, and 0x85 would be transcoded to 0x0085.

When the User ID is 0xFF (unknown or guest user) it shall be transcoded to 0xFFFF (unknown-person-id).

The use of the Person ID is unspecified in 11073-20601 and is implementation specific. Depending upon the implementation, if the User-ID is absent in the characteristic value it may be ignored or transcoded to the unknown-person-id (0xFFFF).

3.3.2.4 MEASUREMENT STATUS

The Measurement Status data field in the Blood Pressure Measurement characteristic is transcoded in a lossy fashion to 11073-20601 Measurement-Status. There are several bits in Measurement Status field that indicate potential measurement problems. If any of these bits is set, the 11073-20601 Measurement-Status is set as “questionable” (0x4000).

If all these measurement status bits are zero, or if measurement status is not present, the 11073-20601 Measurement-Status is absent. The Blood Pressure Feature characteristic is needed in order to ascertain whether the Measurement Status data field is valid.

Measurement Status field bit (LSB)	11073-20601 Measurement-Status
0 (body movement)	0x4000 (questionable)
1 (cuff fit)	0x4000 (questionable)
2 (irregular pulse)	0x4000 (questionable)
3 (pulse rate range)	0x4000 (questionable)
5 (measurement position)	0x4000 (questionable)
Other bits	Reserved for future use

Table 19: Measurement Status bit field relationship with Measurement-Status

3.3.2.5 BLOOD PRESSURE FEATURE

The Blood Pressure Feature characteristic of the Blood Pressure Service is used to assist in the generation of the 11073-20601 Measurement-Status attribute. If the Blood Pressure Feature characteristic indicates no support for reporting measurement status error conditions, the measurement status field in the Blood Pressure Measurement characteristic shall be ignored. In this

case the transcoded objects from the Blood Pressure Measurement characteristic shall have no Measurement-Status attribute.

3.4 GLUCOSE METER

This section defines transcoding of the glucose meter device-specific data into IEEE 11073-10417 Glucose Meter device specialization [11] class attributes.

The Glucose Meter device specialization specifies two ways to transmit data to Manager: event reports or having a PM-Store. They are mutually exclusive; that is, if the configuration has a PM-Store, it shall not send real time agent-init measurement events. The Bluetooth Glucose Service supports only the concept of stored data. The stored data is accessed by the Collector using Record Access Control Point (RACP) procedures. The result is that the Collector receives one or more Glucose Measurement characteristics. *This paper is only concerned with the transcoding of these Glucose Measurement characteristics into their respective 11073-10417 metric objects*. Any mapping of the set of PM Store and PM Segment objects and their respective APDU sequences to the Bluetooth Glucose Service RACP procedures is implementation specific.

3.4.1 DEVICE-SPECIFIC MDS CLASS REQUIREMENTS

In addition to the MDS class requirements shown in Section 2.1, Table 20 shows incremental MDS class requirements specific to this device.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
System-Type	N/A	N/A	N/A	TYPE[1]	(INT-U16, INT-U16)
System-Type-Spec-List	N/A	N/A	N/A	TypeVerList[2]	List of (INT-U16, INT-U16)

Table 20: Device-specific MDS Class Requirements

Notes:

1. Value is not present since System-Type-Spec-List exists.
2. Since the “Glucose Service” [12] is a “Primary Service”, the following entries are required to be added to the TypeVerList:

   0x10 0x11 Specialization value = MDC_DEV_SPEC_PROFILE_GLUCOSE
   0x00 0x02 version = version 2 of the 11073-10417 device specialization

The Date-and-Time attribute (specified in section 2.1 and described in detail in sections 2.2.4 and 2.2.6) is required since the Glucose Sensor has stored data.

3.4.2 11073-10417 NUMERIC CLASS REQUIREMENTS

This section describes the 11073-10417 numeric class requirements. It is restricted to those 11073-10417 attributes that are used on the Glucose Sensor device.

3.4.2.1 DERIVATION OF ABSOLUTE TIME STAMP

The Absolute Time Stamp of each observation is derived from the mandatory Base Time field of the Glucose Measurement characteristic, together with a potential adjustment due to the Time Offset value. The measurement characteristic may contain the optional Time Offset which is analogous to the Date-and-Time-Adjustment attribute in 11073-20601 (though Time Offset is expressed in minutes).

While there are similarities between the Time Offset field and the Date-and-Time-Adjustment attribute of 11073-20601 in the Glucose meter, there are differences. Specifically, the Date-and-Time-Adjustment contains individual adjustments, whereas each Time Offset is the *total* time adjustment applied on Base Time, up to the moment of the respective measurement..

The Date-and-Time-Adjustment is thus the difference between a given offset and the first offset received. Thus the Base Time plus first offset received in an RACP transaction (the first packet received in an RACP transaction *always* contains an offset) transcodes to the Absolute Time stamp and the difference between any subsequent offset and the first offset is equivalent to the cumulative date time adjustment.

3.4.2.2 BLOOD GLUCOSE OBJECTS

Each 11073-10417 object has a static TYPE related to the type of blood sample (capillary plasma, control solution etc.). The 11073-20601 Manager (Collector) obtains all the types supported by the device during configuration and creates its DIM objects based upon this information. A GATT-based Bluetooth device does not provide such information and to follow the 11073-20601 model a generic transcoder would need to populate its DIM with a numeric metric object for each of the possible supported TYPEs (a total of ten) even though only one may be used. In practice an implementation would likely create the numeric metric object on the fly as needed or obtain the information from the RACP procedures (replacing the configuration procedure of 11073-20601) and creating the DIM prior to invoking the actual data transfer.

Table 21 is the template structure for each of the ten blood glucose objects. Each object has a different TYPE.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE[1]	INT-U16
Type	Glucose Measurement	Glucose	N/A	TYPE[2]	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall[3]	BITS-16
Unit-Code	Glucose Measurement	Glucose	Aggregate	OID-Type[4]	INT-U16
Absolute-Time-Stamp	Glucose Measurement	Glucose	Aggregate	AbsoluteTime[5]	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Basic-Nu-Observed-Value	Glucose Measurement	Glucose	Aggregate	BasicNuObserved Value[6]	SFLOAT-Type

Table 21: 11073-10417 Blood Glucose Numeric Class Requirements

Notes:

1. Each metric object is required to have a unique non-zero ID assigned by the implementation.
2. Each object has a different TYPE, of the ten types specified in [11]. They are related to measurements according to Table 22:

Type Nibble in Glucose Measurement	11073-10417 Type
0x1 (capillary wholeblood)	{MDC_PART_SCADA | MDC_CONC_GLU_CAPILLARY_WHOLEBLOOD}
0x2 (capillary plasma)	{MDC_PART_SCADA | MDC_CONC_GLU_CAPILLARY_PLASMA}
0x3 (venous wholeblood)	{MDC_PART_SCADA | MDC_CONC_GLU_VENOUS_WHOLEBLOOD}
0x4 (venous plasma)	{MDC_PART_SCADA | MDC_CONC_GLU_VENOUS_PLASMA}
0x5 (arterial wholeblood)	{MDC_PART_SCADA | MDC_CONC_GLU_ARTERIAL_WHOLEBLOOD}
0x6 (arterial plasma)	{MDC_PART_SCADA | MDC_CONC_GLU_ARTERIAL_PLASMA}
0x7 (undetermined wholeblood)	{MDC_PART_SCADA | MDC_CONC_GLU_UNDETERMINED_WHOLEBLOOD}
0x8 (undetermined plasma)	{MDC_PART_SCADA | MDC_CONC_GLU_UNDETERMINED_PLASMA}
0x9 (interstitial fluid – ISF)	{MDC_PART_SCADA | MDC_CONC_GLU_ISF}
0xA (control solution)	{MDC_PART_SCADA | MDC_CONC_GLU_CONTROL}
0xF (type not available)	N/A

Table 22: Object Type relationship with measurement type

3. Set to 0xF040 (mss-avail-intermittent | mss-avail-stored-data | mss-upd-aperiodic | mss-msmt-aperiodic | mss-acc-agent-initiated).
4. This value is mapped from Bit 1 of the Flags field of the Glucose Measurement characteristic. The characteristic unit is kg/L (when flag is 0) or mol/L (when flag is 1). The transcoded units are not the same as the characteristic units, but the selection of unit codes allow conversion of measurement values by simple scaling. The mapping is as follows:

11073-10417 Glucose Unit Value	Bluetooth Glucose Unit Value	Unit Description
MDC_DIM_MILLI_G_PER_DL	0	mg/dL
MDC_DIM_MILLI_MOLE_PER_L	1	mmol/L

Table 23: Glucose: Glucose Unit Conversion

5. This value is derived from the mandatory Base Time field of Glucose Measurement characteristic (which is mandatory), added by the optional Time Offset field of the same characteristic. See section 3.4.2.1 for details.
6. This value is derived from Glucose Concentration value of Glucose Measurement characteristic. The value shall be converted to match the selected Unit-Code. If the characteristic unit is kg/L, the transcoded unit shall be mg/dL and the units are different by a factor of 10^5. If the characteristic unit is mol/L, the transcoded unit shall be mmol/L and the units are different by a factor of 10^3. Both conversions are implemented by adding 5 and 3 to SFLOAT exponent, respectively, without changing the mantissa.

   If measurement value is above device capabilities, value shall be +INFINITY. Symmetrically, if

measurement is below device capabilities, value shall be –INFINITY. Both conditions can be detected in Sensor Status Annunciation Value Field of Glucose Measurement characteristic, bits 5 and 6 respectively. Device may report a NaN or NRes value as well to signal some problem during measurement, which shall be transcoded as is.

The Sequence Number of the Glucose Measurement characteristic is equivalent to the scan-report number in scan event reports. It assures the Manager that a measurement is not lost or dropped. Its use is implementation specific. It has no influence on the measurement itself.

3.4.2.3 HEMOGLOBIN BOUND TO GLUCOSE A1C FORM

Optionally transcoded when Glucose Measurement Context characteristic is present and the Flags field of that characteristic signals (in bit 6) that HbA1c value is present.

Note that a measurement may lack glucose concentration and still contain a HbA1c value.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE[1]	INT-U16
Type	N/A	N/A	N/A	TYPE[2]	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall[3]	BITS-16
Unit-Code	N/A	N/A	N/A	OID-Type[4]	INT-U16
Absolute-Time-Stamp	Glucose Measurement	Glucose	Aggregate	AbsoluteTime[5]	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Basic-Nu-Observed-Value	Glucose Measurement Context	Glucose	Aggregate	BasicNuObserved Value[6]	SFLOAT-Type

Table 24: 11073-10417 HbA1c Numeric Class Requirements

Notes:

1. Each metric object is required to have a unique non-zero ID assigned by the implementation.
2. Value set to MDC_PART_SCADA | MDC_CONC_HBA1C.
3. Set to 0xF048 (mss-avail-intermittent | mss-avail-stored-data | mss-upd-aperiodic | mss-msmt-aperiodic | mss-acc-agent-initiated | mss-cat-manual).
4. Unit is MDC_DIM_PERCENT.
5. This value is derived from the mandatory Base Time field of Glucose Measurement characteristic (which is mandatory), added by the optional Time Offset field of the same characteristic. See section 3.4.2.1 for details.
6. This value is derived from HbA1c value of Glucose Measurement Context characteristic.

3.4.2.4 CONTEXT EXERCISE

Optionally transcoded when Glucose Measurement Context characteristic is present and the Flags field of that characteristic signals (in bit 3) that exercise value is present.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth data type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE[1]	INT-U16
Type	N/A	N/A	N/A	TYPE[2]	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall[3]	BITS-16
Unit-Code	N/A	N/A	N/A	OID-Type[4]	INT-U16
Absolute-Time-Stamp	Glucose Measurement	Glucose	Aggregate	AbsoluteTime[5]	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Measure-Active-Period	Glucose Measurement Context	Glucose	Aggregate	FLOAT-Type[6]	FLOAT-Type
Basic-Nu-Observed-Value	Glucose Measurement Context	Glucose	Aggregate	BasicNuObserved Value[7]	SFLOAT-Type

Table 25: 11073-10417 Context Exercise Numeric Class Requirements

Notes:

1. Each metric object is required to have a unique non-zero ID assigned by the implementation.
2. Value set to MDC_PART_PHD_DM | MDC_CTXT_GLU_EXERCISE.
3. Set to 0xF048 (mss-avail-intermittent | mss-avail-stored-data | mss-upd-aperiodic | mss-msmt-aperiodic | mss-acc-agent-initiated | mss-cat-manual).
4. Unit is MDC_DIM_PERCENT.
5. This value is derived from the mandatory Base Time field of Glucose Measurement characteristic (which is mandatory), added by the optional Time Offset field of the same characteristic. See section 3.4.2.1 for details.
6. This value is derived from Exercise Duration value of Glucose Measurement Context characteristic. Value is converted to FLOAT with an exponent of 0.
7. This value is derived from Exercise Intensity value of Glucose Measurement Context characteristic. Value is converted to SFLOAT with an exponent of 0.

3.4.2.5 CONTEXT MEDICATION

Optionally transcoded when Glucose Measurement Context characteristic is present and the Flags field of that characteristic signals (in bit 4) that medication value is present.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE[1]	INT-U16
Type	N/A	N/A	N/A	TYPE[2]	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall[3]	BITS-16
Metric-Id	Glucose Measurement Context	Glucose	Aggregate	OID-Type[4]	INT-U16
Unit-Code	Glucose Measurement Context	Glucose	Aggregate	OID-Type[5]	INT-U16
Absolute-Time-Stamp	Glucose Measurement	Glucose	Aggregate	AbsoluteTime[6]	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Basic-Nu-Observed-Value	Glucose Measurement Context	Glucose	Aggregate	BasicNuObserved Value[7]	SFLOAT-Type

Table 26: 11073-10417 Context Medication Numeric Class Requirements

Notes:

1. Each metric object is required to have a unique non-zero ID assigned by the implementation.
2. Value is set to MDC_PART_PHD_DM | MDC_CTXT_MEDICATION.
3. Set to 0xF048 (mss-avail-intermittent | mss-avail-stored-data | mss-upd-aperiodic | mss-msmt-aperiodic | mss-acc-agent-initiated | mss-cat-manual).
4. Value is set based on Medication ID Value field of Glucose Measurement Context characteristic, according to the following table:

Medication ID	11073-10417 Value
0x1 (rapid action insulin)	MDC_CTXT_MEDICATION_RAPIDACTING
0x2 (short acting insulin)	MDC_CTXT_MEDICATION_SHORTACTING
0x3 (intermediate acting insulin)	MDC_CTXT_MEDICATION_INTERMEDIATEACTING
0x4 (long acting insulin)	MDC_CTXT_MEDICATION_LONGACTING
0x5 (pre-mixed insulin)	MDC_CTXT_MEDICATION_PREMIX

Table 27: Medication ID and Metric ID relationship

5. Unit is set based on Medication Units Flag (bit 5 of Flags of the Glucose Measurement Context characteristic), according to the following table:

Medication Units Flag	11073-10417 Value	Unit
0x0	MDC_DIM_MILLI_G	mg
0x1	MDC_DIM_MILLI_L	ml

Table 28: Medication Units Flag and Unit relationship

Note that characteristic value has unit of kilogram (kg) or liter (L), while the transcoded unit code is milligram (mg) or mililiter (mL) respectively, so the medication value needs to be converted.

6. This value is derived from the mandatory Base Time field of Glucose Measurement characteristic (which is mandatory), added by the optional Time Offset field of the same characteristic. See section 3.4.2.1 for details.
7. This value is derived from Medication Value of Glucose Measurement Context characteristic. The value shall be converted to match the selected Unit-Code. If the characteristic medication unit is kg, the transcoded unit shall be mg, and the units are different by a factor of 10^6. If the characteristic medication unit is L, the transcoded unit shall be mL and the units are different by a factor of 10^3. Both conversions are implemented by adding 6 and 3 to SFLOAT exponent, respectively, without changing the mantissa.

3.4.2.6 CONTEXT CARBOHYDRATES

Optionally transcoded when Glucose Measurement Context characteristic is present and the Flags field of that characteristic signals (in bit 0) that carbohydrates value is present.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE[1]	INT-U16
Type	N/A	N/A	N/A	TYPE[2]	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall[3]	BITS-16
Metric-Id	Glucose Measurement Context	Glucose	Aggregate	OID-Type[4]	INT-U16
Unit-Code	N/A	N/A	N/A	OID-Type[5]	INT-U16
Absolute-Time-Stamp	Glucose Measurement	Glucose	Aggregate	AbsoluteTime[6]	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Basic-Nu-Observed-Value	Glucose Measurement Context	Glucose	Aggregate	BasicNuObserved Value[7]	SFLOAT-Type

Table 29: 11073-10417 Context Carbohydrates Numeric Class Requirements

Notes:

1. Each metric object is required to have a unique non-zero ID assigned by the implementation.
2. Value set to MDC_PART_PHD_DM | MDC_CTXT_GLU_CARB.
3. Set to 0xF048 (mss-avail-intermittent | mss-avail-stored-data | mss-upd-aperiodic | mss-msmt-aperiodic | mss-acc-agent-initiated | mss-cat-manual).
4. Value is set based on Carbohydrate ID Value field of Glucose Measurement Context characteristic, according to the following table:

Carbohydrate ID	11073-10417 Value
0x1 (breakfast)	MDC_CTXT_GLU_CARB_BREAKFAST
0x2 (lunch)	MDC_CTXT_GLU_CARB_LUNCH
0x3 (dinner)	MDC_CTXT_GLU_CARB_DINNER
0x4 (snack)	MDC_CTXT_GLU_CARB_SNACK
0x5 (drink)	MDC_CTXT_GLU_CARB_DRINK
0x6 (supper)	MDC_CTXT_GLU_CARB_SUPPER
0x7 (brunch)	MDC_CTXT_GLU_CARB_BRUNCH

Table 30: Carbohydrate ID and Metric Id relationship

5. Unit is MDC_DIM_X_G. Note that characteristic value has unit of kilogram, while this transcoded unit code is gram, so the carbohydrate value needs to be converted.
6. This value is derived from the mandatory Base Time field of Glucose Measurement characteristic (which is mandatory), added by the optional Time Offset field of the same characteristic. See section 3.4.2.1 for details.
7. This value is derived from Carbohydrate Value of Glucose Measurement Context characteristic. The characteristic unit is kg, transcoded unit is g, and the units are different by a factor of 10^3. Conversion is achieved by adding 3 to SFLOAT exponent, without changing the mantissa.

3.4.3 ENUMERATION OBJECTS

This section describes the 11073-10417 enumeration class requirements. It is restricted to those 11073 attributes that are used on the Glucose Sensor device.

3.4.3.1 DEVICE AND SENSOR ANNUNCIATION

Optionally transcoded when Glucose Measurement characteristic contains the Sensor Status Annunciation Value field.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE[1]	INT-U16
Type	N/A	N/A	N/A	TYPE[2]	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall[3]	BITS-16
Absolute-Time-Stamp	Glucose Measurement	Glucose	Aggregate	AbsoluteTime[4]	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Enum-Observed-Value-Basic-Bit-Str	Glucose Measurement	Glucose	Aggregate	BITS-16[5]	BITS-16

Table 31: 11073-10417 Device and Sensor Annunciation Enumeration Class Requirements

Notes:

1. Each metric object is required to have a unique non-zero ID assigned by the implementation.
2. Value set to MDC_PART_PHD_DM | MDC_GLU_METER_DEV_STATUS
3. Set to 0xF040 (mss-avail-intermittent | mss-avail-stored-data | mss-upd-aperiodic | mss-msmt-aperiodic | mss-acc-agent-initiated).
4. This value is derived from the mandatory Base Time field of Glucose Measurement characteristic (which is mandatory), added by the optional Time Offset field of the same characteristic. See section 3.4.2.1 for details.
5. This value is derived from Sensor Status Annunciation Value Field of the Glucose Measurement characteristic. Bits with value 1 mean that the respective failure mode has happened at measurement time. The bitmap is composed according to Table 32:

11073-10417 Device Or Sensor Condition Bit (GlucoseDevStat) Bit 0 is MSB	Bluetooth Sensor Status Annunciation Bit Bit 0 is LSB
device-battery-low (0)	0 (device battery low)
sensor-malfunction (1)	1 (sensor malfunction)

11073-10417 Device Or Sensor Condition Bit (GlucoseDevStat) Bit 0 is MSB	Bluetooth Sensor Status Annunciation Bit Bit 0 is LSB
sensor-sample-size-insufficient (2)	2 (sample size insufficient, not enough blood or control solution)
sensor-strip-insertion (3)	3 (strip insertion error)
sensor-strip-type-incorrect (4)	4 (strip type is incorrect)
sensor-result-too-high (5)	5 (sensor result higher than device can process)
sensor-result-too-low (6)	6 (sensor result lower than device can process)
sensor-temp-too-high (7)	7 (ambient temperature too high for a valid test/result)
sensor-temp-too-low (8)	8 (ambient temperature too low for a valid test/result)
sensor-read-interrupt (9)	9 (reading was interrupted and/or strip was pulled too soon)
device-gen-fault (10)	10 (general device fault)
No correspondence	11 (time fault)

Table 32: Relationship between Sensor Status Annunciation and 11073-10417 sensor condition

For example, if the battery was low and on top of that the user pulled the strip too soon, the Sensor status value would be 0x0201 (bits 0 and 9 LSB set), and the 11073-20601 transcoded value would be 0x8040 (bits 0 and 9 MSB set).

3.4.3.2 CONTEXT MEAL

Optionally transcoded when Glucose Measurement Context characteristic is present and the respective Flags field indicates that Meal Value field is present.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE[1]	INT-U16
Type	N/A	N/A	N/A	TYPE[2]	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall[3]	BITS-16
Absolute-Time-Stamp	Glucose Measurement	Glucose	Aggregate	AbsoluteTime[4]	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Enum-Observed-Value-Simple-OID	Glucose Measurement Context	Glucose	Aggregate	OID-Type[5]	INT-U16

Table 33: 11073-10417 Context Meal Enumeration Class Requirements

Notes:

1. Each metric object is required to have a unique non-zero ID assigned by the implementation.
2. Value set to MDC_PART_PHD_DM | MDC_CTXT_GLU_MEAL.
3. Set to 0xF048 (mss-avail-intermittent | mss-avail-stored-data | mss-upd-aperiodic | mss-msmt-aperiodic | mss-acc-agent-initiated | mss-cat-manual).

4. This value is derived from the mandatory Base Time field of Glucose Measurement characteristic (which is mandatory), added by the optional Time Offset field of the same characteristic. See section 3.4.2.1 for details.
5. This value is derived from Meal Value Field of the Glucose Measurement Context characteristic, according to Table 34:

11073-10417 Nomenclature Value	Bluetooth Meal Value
MDC_CTXT_GLU_MEAL_PREPRANDIAL	0x1 (preprandial – before meal)
MDC_CTXT_GLU_MEAL_POSTPRANDIAL	0x2 (postprandial – after meal)
MDC_CTXT_GLU_MEAL_FASTING	0x3 (fasting)
MDC_CTXT_GLU_MEAL_CASUAL	0x4 (casual – snacks, drinks etc.)
MDC_CTXT_GLU_MEAL_BEDTIME	0x5 (bedtime)

Table 34: Relationship between Bluetooth Meal value and context meal enumeration

3.4.3.3 CONTEXT SAMPLE LOCATION

Optionally transcoded when Glucose Measurement characteristic contains the Type/Sample Location Value field, and the Sample nibble value of this field is different from 0xF (0xF means sample location not available).

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE[1]	INT-U16
Type	N/A	N/A	N/A	TYPE[2]	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall[3]	BITS-16
Absolute-Time-Stamp	Glucose Measurement	Glucose	Aggregate	AbsoluteTime[4]	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Enum-Observed-Value-Simple-OID	Glucose Measurement	Glucose	Aggregate	OID-Type[5]	INT-U16

Table 35: 11073-10417 Context Sample Location Enumeration Class Requirements

Notes:

1. Each metric object is required to have a unique non-zero ID assigned by the implementation.
2. Value set to MDC_PART_PHD_DM | MDC_CTXT_GLU_SAMPLELOCATION
3. Set to 0xF048 (mss-avail-intermittent | mss-avail-stored-data | mss-upd-aperiodic | mss-msmt-aperiodic | mss-acc-agent-initiated | mss-cat-manual).
4. This value is derived from the mandatory Base Time field of Glucose Measurement characteristic (which is mandatory), added by the optional Time Offset field of the same characteristic. See section 3.4.2.1 for details.
5. This value is derived from Sample Location nibble in Type/Sample Location Value Field of the Glucose Measurement characteristic, according to Table 36:

11073-10417 Nomenclature Value	Bluetooth Sample Location Nibble Value
MDC_CTXT_GLU_SAMPLELOCATION_FINGER	0x1 (finger)
MDC_CTXT_GLU_SAMPLELOCATION_AST	0x2 (alternate site test)
MDC_CTXT_GLU_SAMPLELOCATION_EARLOBE	0x3 (earlobe)

11073-10417 Nomenclature Value	Bluetooth Sample Location Nibble Value
MDC_CTXT_GLU_SAMPLELOCATION_CTRLSOLUTION	0x4 (control solution)

Table 36: Relationship between Bluetooth Sample Location and location nomenclature

3.4.3.4 CONTEXT TESTER

Optionally transcoded when Glucose Measurement Context characteristic is present, the respective Flags field indicates that Tester/Health field is present, and Tester nibble value of this field is different from 0xF (0xF means health value not available).

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE[1]	INT-U16
Type	N/A	N/A	N/A	TYPE[2]	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall[3]	BITS-16
Absolute-Time-Stamp	Glucose Measurement	Glucose	Aggregate	AbsoluteTime[4]	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Enum-Observed-Value-Simple-OID	Glucose Measurement Context	Glucose	Aggregate	OID-Type[5]	INT-U16

Table 37: 11073-10417 Context Tester Enumeration Class Requirements

Notes:

1. Each metric object is required to have a unique non-zero ID assigned by the implementation.
2. Value set to MDC_PART_PHD_DM | MDC_CTXT_GLU_TESTER.
3. Set to 0xF048 (mss-avail-intermittent | mss-avail-stored-data | mss-upd-aperiodic | mss-msmt-aperiodic | mss-acc-agent-initiated | mss-cat-manual).
4. This value is derived from the mandatory Base Time field of Glucose Measurement characteristic (which is mandatory), added by the optional Time Offset field of the same characteristic. See section 3.4.2.1 for details.
5. This value is derived from Tester nibble in Tester/Health Value Field of the Glucose Measurement Context characteristic, according to Table 38:

11073-10417 Nomenclature Value	Bluetooth Tester Nibble Value
MDC_CTXT_GLU_TESTER_SELF	0x1 (self)
MDC_CTXT_GLU_TESTER_HCP	0x2 (health care professional)
MDC_CTXT_GLU_TESTER_LAB	0x3 (lab test)

Table 38: Relationship between Bluetooth Tester value and tester nomenclature value

3.4.3.5 CONTEXT HEALTH

Optionally transcoded when Glucose Measurement Context characteristic is present, the respective Flags field indicates that Tester/Health field is present, and Health nibble value of this field is different from 0xF (0xF means health value not available).

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE[1]	INT-U16
Type	N/A	N/A	N/A	TYPE[2]	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall[3]	BITS-16
Absolute-Time-Stamp	Glucose Measurement	Glucose	Aggregate	AbsoluteTime[4]	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Enum-Observed-Value-Simple-OID	Glucose Measurement Context	Glucose	Aggregate	OID-Type[5]	INT-U16

Table 39: 11073-10417 Context Health Enumeration Class Requirements

Notes:

1. Each metric object is required to have a unique non-zero ID assigned by the implementation.
2. Value set to MDC_PART_PHD_DM | MDC_CTXT_GLU_HEALTH.
3. Set to 0xF048 (mss-avail-intermittent | mss-avail-stored-data | mss-upd-aperiodic | mss-msmt-aperiodic | mss-acc-agent-initiated | mss-cat-manual).
4. This value is derived from the mandatory Base Time field of Glucose Measurement characteristic (which is mandatory), added by the optional Time Offset field of the same characteristic. See section 3.4.2.1 for details.
5. Derived from Health nibble in Tester/Health Value Field of the Glucose Measurement Context characteristic, according to Table 40:

11073-10417 Nomenclature Value	Bluetooth Health Nibble Value
MDC_CTXT_GLU_HEALTH_MINOR	0x1 (minor health issues)
MDC_CTXT_GLU_HEALTH_MAJOR	0x2 (major health issues)
MDC_CTXT_GLU_HEALTH_MENSES	0x3 (menses)
MDC_CTXT_GLU_HEALTH_STRESS	0x4 (under stress)
MDC_CTXT_GLU_HEALTH_NONE	0x5 (no health issues)

Table 40: Relationship between Bluetooth Health nibble in Tester/Health Value Field and Context Health nomenclature

3.5 WEIGHT SCALE

This section defines transcoding the weight scale device-specific data into IEEE 11073-10415 Weighing Scale [20] and IEEE 11073-10420 Body Composition [21] device specialization class attributes.

3.5.1 DEVICE-SPECIFIC MDS CLASS REQUIREMENTS

In addition to the MDS class requirements shown in Section 2.1, Table 41 shows incremental MDS class requirements specific to this device.

11073-20601 Attribute	Bluetooth equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
System-Type	N/A	N/A	N/A	TYPE[1]	(INT-U16, INT-U16)

System-Type-Spec-List	N/A	N/A	N/A	TypeVerList[2]	List of (INT-U16, INT-U16)

Table 41: Device-specific MDS Class Requirements

Notes:

1. Value not present since System-Type-Spec-List exists.
2. If the Sensor exposes only the Weight Scale Service [18] the following entry is required to be added to the TypeVerList:

   0x10 0x0F Specialization value = MDC_DEV_SPEC_PROFILE_SCALE

   0x00 0x01 version = version 1 of the 11073-10415 device specialization

   If the Sensor exposes both the Weight Scale Service [18] and the Body Composition Service [19] the following entry is required to be added to the TypeVerList:

   0x10 0x14 Specialization value = MDC_DEV_SPEC_PROFILE_BCA

   0x00 0x01 version = version 1 of the 11073-10420 device specialization

3.5.2 WEIGHT SCALE FEATURE

The Weight Scale Feature characteristic of the Weight Scale Service contains the weight and height measurement resolutions.

Weight measurement resolution is specified by bits 3 to 6, according to Table 42. Note that resolution value is little-endian, so the LSB is bit 3 and MSB is bit 6.

Height measurement resolution is specified by bits 7 to 9, according to Table 43. Note that this resolution value is little endian as well.

Other than these resolution bits, the Weight Scale Feature characteristic of the Weight Scale Service does not contain additional information for transcoding, since it merely describes which optional features may appear in the measurement.

Weight Scale Feature Weight Measurement Resolution (bits 6, 5, 4, 3)	Resolution	Exponent for kg	Exponent for lb
0b0000	Not specified	-3	-2
0b0001	0.5kg/1lb	-1	0
0b0010	0.2kg/0.5lb	-1	-1
0b0011	0.1kg/0.2lb	-1	-1
0b0100	0.05kg/0.1lb	-2	-1
0b0101	0.02kg/0.05lb	-2	-2
0b0110	0.01kg/0.02lb	-2	-2
0b0111	0.005kg/0.01lb	-3	-2
0b1000 to 0b1111	Reserved for future use	N/A	N/A

Table 42: Weight Scale Feature: Weight Measurement Resolution

The exponent for the transcoded Weight value (Section 3.5.4.1) should be chosen according to the value of Weight Measurement Resolution bits and the measurement unit (SI or Imperial).

Weight Scale Feature Height Measurement Resolution (bits 9, 8, 7)	Resolution	Exponent for m	Exponent for in
0b000	Not specified	-3	-1
0b001	0.01m/1in	-2	0
0b010	0.005m/0.5in	-3	-1
0b011	0.001m/0.1in	-3	-1
0b100 to 0b111	Reserved for future use	N/A	N/A

Table 43: Weight Scale Feature: Height Measurement Resolution

The exponent for the transcoded Height value (Section 3.5.4.2) should be chosen according to the value of Height Measurement Resolution bits and the measurement unit (SI or Imperial).

3.5.3 BODY COMPOSITION FEATURE

The Body Composition Feature characteristic of the Body Composition Service contains the Body Mass and Height measurement resolutions.

The Mass Measurement Resolution is specified by bits 11, 12, 13 and 14, according to Table 44. Note that resolution value is little-endian, so the LSB is bit 11 and MSB is bit 14.

The Height resolution is specified by bits 15, 16 and 17, according to Table 45. The resolution value is little-endian as the Mass resolution.

Note that, in the context of Weight Scale Profile, the Body Composition Service shall not include the Height and Weight fields in measurements. In the absence of Height, the Height Resolution bits of Body Composition Feature are meaningless and shall be zero.

Other than these resolution bits, the Body Composition Feature characteristic of the Body Composition Service does not contain additional information for transcoding, since it merely describes which optional features may appear in the measurement.

Body Composition Feature Mass Measurement Resolution (bits 14, 13, 12, 11)	Resolution	Exponent for kg	Exponent for lb
0b0000	Not specified	-3	-2
0b0001	0.5kg/1lb	-1	0
0b0010	0.2kg/0.5lb	-1	-1
0b0011	0.1kg/0.2lb	-1	-1
0b0100	0.05kg/0.1lb	-2	-1
0b0101	0.02kg/0.05lb	-2	-2
0b0110	0.01kg/0.02lb	-2	-2
0b0111	0.005kg/0.01lb	-3	-2
0b1000 to 0b1111	Reserved for future use	N/A	N/A

Table 44: Body Composition Feature: Mass Measurement Resolution

The exponent for the transcoded mass values (sections 3.5.5.2, 3.5.5.3, 3.5.5.4, and 3.5.5.10) shall be set according to the value of the resolution bits and the mass measurement unit (kg or lb).

Body Composition Feature Height Measurement Resolution (bits 17, 16, 15)	Resolution	Exponent for m	Exponent for in
0b000	Not specified	-3	-1
0b001	0.01m/1in	-2	0
0b010	0.005m/0.5in	-3	-1
0b011	0.001m/0.1in	-3	-1
0b100 to 0b111	Reserved for future use	N/A	N/A

Table 45: Body Composition Feature: Height Measurement Resolution

Table 45 is supplied only for completeness. The Height Resolution bits are not transcoded in the context of Weight Scale transcoding, as Body Composition Service does not include the Height field in this context.

3.5.4 11073-10415 NUMERIC CLASS REQUIREMENTS

This section describes the 11073-10415 numeric class requirements. It is restricted to those 11073-20601 attributes that are used on the Weight Scale device.

3.5.4.1 WEIGHT

Mandatory object, transcoded from Weight Measurement data. Attributes defined in Table 46.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE[1]	INT-U16
Type	N/A	N/A	N/A	TYPE[2]	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall[3]	BITS-16
Unit-Code	Weight Measurement	Weight Scale	Aggregate	OID-Type[4]	INT-U16
Absolute-Time-Stamp	Weight Measurement	Weight Scale	Aggregate	AbsoluteTime[5]	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Simple-Nu-Observed-Value	Weight Measurement	Weight Scale	Aggregate	SimpleNuObsValue[6]	FLOAT-Type

Table 46: 11073-10415 Numeric Class Requirements: Weight

Notes:

1. Each metric object is required to have a unique non-zero ID assigned by the implementation.
2. Set to {MDC_PART_SCADA, MDC_MASS_BODY_ACTUAL}.
3. Set to 0xF040 (mss-avail-intermittent, mss-avail-stored-data, mss-upd-aperiodic, mss-msmt-aperiodic, mss-acc-agent-initiated).

4. This value is mapped from Bit 0 LSB of Flags field of the Weight Measurement characteristic. The mapping is as follows in Table 47:

11073-10415 Weight Unit Value	Bluetooth Measurement Units bit value	Weight Unit Description
MDC_DIM_KILO_G	0	Kilogram
MDC_DIM_LB	1	Pound

Table 47: Weight Unit Type

5. When supported, this value is derived from the Time Stamp field of Weight Measurement characteristic. Time Stamp field is present when bit 1 LSB of Flags field in characteristic is set to1. See Section 2.2.6.

6. The Weight field of the Weight Measurement characteristic has a UINT16 format where the least significant bit represents a value of 0.005kg when the unit is set to kg, and 0.01lb when the unit is set to lb. Therefore if the unit is set to kg and the field value is e.g. 16000, this equates to a weight of 80.000 kg (16000 x 0.005). Similarly, if the unit is set to lb and the field value is e.g. 16000, this equates to a weight of 160.00lb (16000 x 0.01).

   To convert this to a FLOAT, the exponent is selected according to the value of the Weight Measurement Resolution bits (see section 3.5.2 for details) and the weight measurement unit (i.e. kg or lb). The mantissa is scaled according to the exponent. For example, if unit is kg and the measurement is 80kg (field value of 16000), and scale resolution is 0.01kg, the exponent is set to -2 and the mantissa is set to 8000 (16000 x 0.005 x $10^{-(-2)}$).

   In another example, if unit is lb and measurement is 160lb (field value of 16000) and scale resolution is 0.1lb, the exponent is set to -1 and the mantissa is set to 1600 (16000 x 0.01 x $10^{-(-1)}$).

   If the field value is 0xFFFF (65535), this means that the measurement was unsuccessful and the transcoded FLOAT value should be NaN, indicating that measurement is invalid.

   This procedure does not result in loss of precision in the equivalent representation regardless of the selected unit.

3.5.4.2 HEIGHT

Optionally transcoded when Weight Measurement characteristic contains the Height field (i.e. when bit 3 of Flags field equal to 1). Attributes defined in Table 48.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE[1]	INT-U16
Type	N/A	N/A	N/A	TYPE[2]	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall[3]	BITS-16
Unit-Code	Weight Measurement	Weight Scale	Aggregate	OID-Type[4]	INT-U16
Absolute-Time-Stamp	Weight Measurement	Weight Scale	Aggregate	AbsoluteTime[5]	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Simple-Nu-Observed-Value	Weight Measurement	Weight Scale	Aggregate	SimpleNuObsValue[6]	FLOAT-Type

Table 48: 11073-10415 Numeric Class Requirements: Height

Notes:

1. Each metric object is required to have a unique non-zero ID assigned by the implementation.
2. Set to {MDC_PART_SCADA, MDC_LEN_BODY_ACTUAL}.
3. Set to 0xF048 (mss-avail-intermittent, mss-avail-stored-data, mss-upd-aperiodic, mss-msmt-aperiodic, mss-acc-agent-initiated, mss-cat-manual).
4. This value is mapped from Bit 0 LSB of Flags field of the Weight Measurement characteristic. The mapping is as follows in Table 49:

11073-10415 Height Unit Value	Bluetooth Measurement Units bit value	Height Unit Description
MDC_DIM_CENTI_M	0	Centimeter
MDC_DIM_INCH	1	Inch

Table 49: Height Type Description Conversion

5. When supported, this value is derived from the Time Stamp field of Weight Measurement characteristic. Time Stamp field is present when bit 1 LSB of Flags field in characteristic is set to1. See Section 2.2.6.
6. The Height field of the Weight Measurement characteristic has a UINT16 format where each bit represents a value of 0.001m when the unit is set to meters, and 0.1in when the unit is set to inches. Therefore if the unit is set to meters and the field value is e.g. 1715, this equates to a height of 1.715m (1715 x 0.001). Similarly, if the unit is set to inches and the field value is e.g. 677, this equates to a height of 67.7in or 5' 7.7". (These are examples for scale resolutions of 0.1cm and 0.1in, respectively.)

   To convert this to a FLOAT, the exponent is selected according to the value of the Height Measurement Resolution bits (see section 3.5.2 for details) and the height measurement unit (i.e. cm or in). The mantissa is scaled according to the exponent. For example, if unit is m and the measurement is 1.720m (field value of 1720), and scale resolution is 0.01m, the exponent is set to -2 and the mantissa is set to 172 (1720 x 0.001 x $10^{-(-2)}$).

   In another example, if unit is in and measurement is 68.0in (field value of 680) and scale resolution is 1in, the exponent is set to 0 and the mantissa is set to 68 (68 x 0.1 x $10^{-(0)}$).

If the field value is 0xFFFF (65535), this means that the measurement was unsuccessful and the transcoded FLOAT value should be NaN, indicating that measurement is invalid.

3.5.4.3 BODY MASS INDEX (BMI)

Optionally transcoded when Weight Measurement characteristic contains the BMI field (i.e. when bit 3 of Flags field equal to 1). Attributes defined in Table 50.

In 11073-10415, the Height object is mandatory when the BMI object is present. In the Weight Measurement, either both Height and BMI are present or both are absent, as the presence of both is announced by the same bit of Flags field (bit 3: “BMI and Height present”).

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE[1]	INT-U16
Type	N/A	N/A	N/A	TYPE[2]	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall[3]	BITS-16
Unit-Code	Weight Measurement	Weight Scale	Aggregate	OID-Type[4]	INT-U16
Absolute-Time-Stamp	Weight Measurement	Weight Scale	Aggregate	AbsoluteTime[5]	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Simple-Nu-Observed-Value	Weight Measurement	Weight Scale	Aggregate	SimpleNuObsValue[6]	FLOAT-Type

Table 50: 11073-10415 Numeric Class Requirements: BMI

Notes:

1. Each metric object is required to have a unique non-zero ID assigned by the implementation.
2. Set to {MDC_PART_SCADA, MDC_RATIO_MASS_BODY_LEN_SQ}.
3. Set to 0xF042 (mss-avail-intermittent, mss-avail-stored-data, mss-upd-aperiodic, mss-msmt-aperiodic, mss-acc-agent-initiated, mss-cat-calculation).
4. Set to MDC_DIM_KG_PER_M_SQ. It does not change, regardless of bit 0 in Flags field.
5. When supported, this value is derived from the Time Stamp field of Weight Measurement characteristic. Time Stamp field is present when bit 1 LSB of Flags field in characteristic is set to1. See Section 2.2.6.
6. This value is derived from the BMI field of the Weight measurement characteristic by converting from an unsigned 16-bit integer to a FLOAT using an exponent of -1, and attributing the same numeric value of the field to the mantissa. For example, a BMI of 275 is transcoded to a FLOAT with mantissa=275 and exponent=-1. The transcoded value is equal to 27.5. This procedure does not result in loss of precision.

3.5.4.4 USER ID

Weight Measurement contains a User ID field when the bit 2 LSB of Flags field of the characteristic is set to 1.

The 11073-20601 Person-ID is of type INT-U16, while the User ID from the Weight Measurement characteristic is one octet, unsigned. When the User ID is in range 0x00 to 0xFE, conversion shall

keep the numeric value. For example, User ID 0x02 would be transcoded to Person-ID 0x0002, and 0x85 would be transcoded to 0x0085.

When the User ID is 0xFF (unknown or guest user) it shall be transcoded to 0xFFFF (unknown-person-id).

The use of the Person ID is unspecified in 11073-20601 and is implementation specific. Depending upon the implementation, if the User-ID is absent in the characteristic value it may be ignored or transcoded to the unknown-person-id (0xFFFF).

3.5.5 11073-10420 NUMERIC CLASS REQUIREMENTS

This section describes the 11073-10420 numeric class requirements. It is restricted to those 11073-20601 attributes that are used on the Body Composition Analyzer features of the Weight Scale device.

The 11073-10420 specialization has three mandatory numeric objects: Weight, Height and Body Fat. Since Weight is also mandatory for 11073-10415 (Weight Scale), it is already satisfied by section 3.5.4.1. In the other hand, Height is optional for Weight Scale.

Body Composition measurements depend on two conditions to be transcodable:

- Height and BMI are exposed by Weight Scale Service;
- At least the Height object (section 3.5.4.2) is implemented by the transcoder.

The class definitions for Weight and Height objects are exactly the same in 11073-10415 and 11073-10420. They are specified in sections 3.5.4.1 and 3.5.4.2.

Likewise, the optional Body Mass Index object has the same class definition in both specializations and is specified in section 3.5.4.3.

In the context of Weight Scale devices, Weight and Height can only be exposed by the Weight Scale Service, not by the Body Composition Service. Therefore, the data source for Weight and Height is always the Weight Scale Service.

Any given measurement may be transmitted (indicated) in two pieces, to cover the situation when data would not fit in a single indication packet (case of e.g. Low Energy transport when the default ATT_MTU is used). The transcoder should handle the two-part measurement as if it were single-part. See section 3.5.5.12 for details.

3.5.5.1 BODY FAT PERCENTAGE

This mandatory object is transcoded from Body Composition Measurement. While 11073-10420 allows body fat to be expressed either in percentage or absolute weight units, the Body Composition Service always uses percentage.

Attributes defined in Table 51.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE[1]	INT-U16
Type	N/A	N/A	N/A	TYPE[2]	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall[3]	BITS-16
Unit-Code	Body Composition Measurement	Body Composition	Aggregate	OID-Type[4]	INT-U16
Absolute-Time-Stamp	Body Composition Measurement	Body Composition	Aggregate	AbsoluteTime[5]	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Simple-Nu-Observed-Value	Body Composition Measurement	Body Composition	Aggregate	SimpleNuObsValue[6]	FLOAT-Type

Table 51: 11073-10420 Numeric Class Requirements: Body Fat

Notes:

1. Each metric object is required to have a unique non-zero ID assigned by the implementation.
2. Set to {MDC_PART_SCADA, MDC_BODY_FAT}.
3. Set to 0xF042 (mss-avail-intermittent, mss-avail-stored-data, mss-upd-aperiodic, mss-msmt-aperiodic, mss-acc-agent-initiated, mss-cat-calculation).
4. Set to MDC_DIM_PERCENT.
5. When supported, this value is derived from the Time Stamp field of Body Composition Measurement characteristic. Time Stamp field is present when bit 1 LSB of Flags field in characteristic is set to1. See Section 2.2.6.
6. This value is derived from the Body Fat Percentage field of the Body Composition Measurement characteristic by converting from an unsigned 16-bit integer to a FLOAT using an exponent of -1, and attributing the same numeric value of the field to the mantissa. For example, a Body Fat Percentage of 275 is transcoded to a FLOAT with mantissa=275 and exponent=-1. The transcoded value is equal to 27.5.This procedure does not result in loss of precision.

   If the field value is 0xFFFF (65535), this means that the measurement was unsuccessful, and it should be transcoded as a FLOAT NaN. This indicates that the measurement is invalid.

3.5.5.2 FAT FREE MASS

Optionally transcoded when bit 6 of Flags field in Body Composition Measurement is set to 1. Attributes defined in Table 52.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE[1]	INT-U16
Type	N/A	N/A	N/A	TYPE[2]	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall[3]	BITS-16
Unit-Code	Body Composition Measurement	Body Composition	Aggregate	OID-Type[4]	INT-U16
Absolute-Time-Stamp	Body Composition Measurement	Body Composition	Aggregate	AbsoluteTime[5]	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Simple-Nu-Observed-Value	Body Composition Measurement	Body Composition	Aggregate	SimpleNuObsValue[6]	FLOAT-Type

Table 52: 11073-10420 Numeric Class Requirements: Fat Free Mass

Notes:

1. Each metric object is required to have a unique non-zero ID assigned by the implementation.
2. Set to {MDC_PART_SCADA, MDC_MASS_BODY_FAT_FREE}.
3. Set to 0xF040 (mss-avail-intermittent, mss-avail-stored-data, mss-upd-aperiodic, mss-msmt-aperiodic, mss-acc-agent-initiated).
4. This value is mapped from Bit 0 LSB of Flags field of the Body Composition Measurement characteristic. The mapping is as follows in Table 53:

11073-10420 Mass Unit Value	Bluetooth Measurement Units bit value	Mass Unit Description
MDC_DIM_KILO_G	0	Kilogram
MDC_DIM_LB	1	Pound

Table 53: Mass Type Description Conversion

5. When supported, this value is derived from the Time Stamp field of Body Composition Measurement characteristic. Time Stamp field is present when bit 1 LSB of Flags field in characteristic is set to1. See Section 2.2.6.
6. The Fat Free Mass field of the Body Composition Measurement characteristic has a UINT16 format where each bit represents a value of 0.005kg when the unit is set to kg, and 0.01lb when the unit is set to lb. Therefore if the unit is set to kg and the field value is e.g. 16000, this equates to a mass of 80.000 kg (16000 x 0.005). Similarly, if the unit is set to lb and the field value is e.g. 16000, this equates to a mass of 160.00lb (16000 x 0.01).

   To convert this to a FLOAT, the exponent is selected according to the value of the Mass Measurement Resolution bits (see section 3.5.3 for details) and the mass measurement unit (i.e. kg or lb). The mantissa is scaled according to the exponent. For example, if unit is kg and the measurement is 80kg (field value of 16000), and scale resolution is 0.01kg, the exponent is set to -2 and the mantissa is set to 8000 (16000 x 0.005 x $10^{(-2)}$).

   In another example, if unit is lb and measurement is 160lb (field value of 16000) and scale resolution

is 1lb, the exponent is set to -1 and the mantissa is set to 1600 (16000 x 0.01 x $10^{-(-1)}$).

If the field value is 0xFFFF (65535), this means that the measurement was unsuccessful and the transcoded FLOAT value should be NaN, indicating that measurement is invalid.

3.5.5.3 SOFT LEAN MASS

Optionally transcoded when bit 7 of Flags field in Body Composition Measurement is set to 1. Attributes defined in Table 54.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE[1]	INT-U16
Type	N/A	N/A	N/A	TYPE[2]	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall[3]	BITS-16
Unit-Code	Body Composition Measurement	Body Composition	Aggregate	OID-Type[4]	INT-U16
Absolute-Time-Stamp	Body Composition Measurement	Body Composition	Aggregate	AbsoluteTime[5]	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Simple-Nu-Observed-Value	Body Composition Measurement	Body Composition	Aggregate	SimpleNuObsValue[6]	FLOAT-Type

Table 54: 11073-10420 Numeric Class Requirements: Soft Lean Mass

Notes:

1. Each metric object is required to have a unique non-zero ID assigned by the implementation.
2. Set to {MDC_PART_SCADA, MDC_MASS_BODY_SOFT_LEAN}.
3. Set to 0xF040 (mss-avail-intermittent, mss-avail-stored-data, mss-upd-aperiodic, mss-msmt-aperiodic, mss-acc-agent-initiated).
4. This value is mapped from Bit 0 LSB of Flags field of the Body Composition Measurement characteristic. The mapping is as follows in Table 55:

11073-10420 Mass Unit Value	Bluetooth Measurement Units bit value	Mass Unit Description
MDC_DIM_KILO_G	0	Kilogram
MDC_DIM_LB	1	Pound

Table 55: Mass Type Description Conversion

5. When supported, this value is derived from the Time Stamp field of Body Composition Measurement characteristic. Time Stamp field is present when bit 1 LSB of Flags field in characteristic is set to1. See Section 2.2.6.
6. The Soft Lean Mass field of the Body Composition Measurement characteristic has a UINT16 format where each bit represents a value of 0.005kg when the unit is set to kg, and 0.01lb when the unit is set to lb. Therefore if the unit is set to kg and the field value is e.g. 16000, this equates to a mass of 80.000 kg (16000 x 0.005). Similarly, if the unit is set to lb and the field value is e.g. 16000, this

equates to a mass of 160.00lb (16000 x 0.01).

To convert this to a FLOAT, the exponent is selected according to the value of the Mass Measurement Resolution bits (see section 3.5.3 for details) and the mass measurement unit (i.e. kg or lb). The mantissa is scaled according to the exponent. For example, if unit is kg and the measurement is 80kg (field value of 16000), and scale resolution is 0.01kg, the exponent is set to -2 and the mantissa is set to 8000 (16000 x 0.005 x $10^{(-2)}$).

In another example, if unit is lb and measurement is 160lb (field value of 16000) and scale resolution is 0.1lb, the exponent is set to -1 and the mantissa is set to 1600 (16000 x 0.01 x $10^{(-1)}$).

If the field value is 0xFFFF (65535), this means that the measurement was unsuccessful and the transcoded FLOAT value should be NaN, indicating that measurement is invalid.

3.5.5.4 BODY WATER MASS

Optionally transcoded when bit 8 of Flags field in Body Composition Measurement is set to 1. Attributes defined in Table 56.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE[1]	INT-U16
Type	N/A	N/A	N/A	TYPE[2]	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall[3]	BITS-16
Unit-Code	Body Composition Measurement	Body Composition	Aggregate	OID-Type[4]	INT-U16
Absolute-Time-Stamp	Body Composition Measurement	Body Composition	Aggregate	AbsoluteTime[5]	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Simple-Nu-Observed-Value	Body Composition Measurement	Body Composition	Aggregate	SimpleNuObsValue[6]	FLOAT-Type

Table 56: 11073-10420 Numeric Class Requirements: Body Water Mass

Notes:

1. Each metric object is required to have a unique non-zero ID assigned by the implementation.
2. Set to {MDC_PART_SCADA, MDC_MASS_BODY_WATER}.
3. Set to 0xF040 (mss-avail-intermittent, mss-avail-stored-data, mss-upd-aperiodic, mss-msmt-aperiodic, mss-acc-agent-initiated).
4. This value is mapped from Bit 0 LSB of Flags field of the Body Composition Measurement characteristic. The mapping is as follows in Table 57:

11073-10420 Mass Unit Value	Bluetooth Measurement Units bit value	Mass Unit Description
MDC_DIM_KILO_G	0	Kilogram
MDC_DIM_LB	1	Pound

Table 57: Mass Type Description Conversion

5. When supported, this value is derived from the Time Stamp field of Body Composition Measurement characteristic. Time Stamp field is present when bit 1 LSB of Flags field in characteristic is set to1. See Section 2.2.6.

6. The Body Water Mass field of the Body Composition Measurement characteristic has a UINT16 format where each bit represents a value of 0.005kg when the unit is set to kg, and 0.01lb when the unit is set to lb. Therefore if the unit is set to kg and the field value is e.g. 16000, this equates to a mass of 80.000 kg (16000 x 0.005). Similarly, if the unit is set to lb and the field value is e.g. 16000, this equates to a mass of 160.00lb (16000 x 0.01).

   To convert this to a FLOAT, the exponent is selected according to the value of the Mass Measurement Resolution bits (see section 3.5.3 for details) and the mass measurement unit (i.e. kg or lb). The mantissa is scaled according to the exponent. For example, if unit is kg and the measurement is 80kg (field value of 16000), and scale resolution is 0.01kg, the exponent is set to -2 and the mantissa is set to 8000 ($16000 \times 0.005 \times 10^{-(-2)}$).

   In another example, if unit is lb and measurement is 160lb (field value of 16000) and scale resolution is 0.1lb, the exponent is set to -1 and the mantissa is set to 1600 ($16000 \times 0.01 \times 10^{-(-1)}$).

   If the field value is 0xFFFF (65535), this means that the measurement was unsuccessful and the transcoded FLOAT value should be NaN, indicating that measurement is invalid.

3.5.5.5 WEIGHT

This value in Body Composition Measurement (present when bit 10 of Flags field is equal to 1) is not used in the context of the Weight Scale Profile, since the weight information comes from the Weight Measurement characteristic (see section 3.5.4.1).

3.5.5.6 HEIGHT

This value in Body Composition Measurement (present when bit 11 of Flags field is equal to 1) is not used in the context of the Weight Scale Profile, since the height information comes from the Weight Measurement characteristic (see section 3.5.4.2).

3.5.5.7 IMPEDANCE

This value is optionally transcoded when bit 9 of the Flags field in the Body Composition Measurement is set to 1. Attributes are defined in Table 58.

This attribute is not specified in the current version of the 11073-10420 specialization.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE[1]	INT-U16
Type	N/A	N/A	N/A	TYPE[2]	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall[3]	BITS-16
Unit-Code	Body Composition Measurement	Body Composition	Aggregate	OID-Type[4]	INT-U16
Absolute-Time-Stamp	Body Composition Measurement	Body Composition	Aggregate	AbsoluteTime[5]	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Simple-Nu-Observed-Value	Body Composition Measurement	Body Composition	Aggregate	SimpleNuObsValue[6]	FLOAT-Type

Table 58: Numeric Class: Impedance

Notes:

1. Each metric object is required to have a unique non-zero ID assigned by the implementation.
2. Set to “Body electrical impedance” {MDC_PART_SCADA, 57708}. This unit code has been reserved but does not have a Ref ID yet.
3. Set to 0xF040 (mss-avail-intermittent, mss-avail-stored-data, mss-upd-aperiodic, mss-msmt-aperiodic, mss-acc-agent-initiated).
4. Set to MDC_DIM_X_OHM.
5. When supported, this value is derived from the Time Stamp field of Body Composition Measurement characteristic. Time Stamp field is present when bit 1 LSB of Flags field in characteristic is set to1. See Section 2.2.6.
6. The Impedance field of the Body Composition Measurement characteristic has a UINT16 format where each bit represents a value of 0.1 ohm. It is transcoded to FLOAT by setting the exponent to -1 and attributing the unchanged numeric value from the Impedance field to the mantissa.

   If the field value is 0xFFFF (65535), this means that the measurement was unsuccessful and the transcoded FLOAT value should be NaN, indicating that measurement is invalid.

3.5.5.8 BASAL METABOLISM

This value is optionally transcoded when bit 3 of the Flags field in the Body Composition Measurement is set to 1. Attributes are defined in Table 59.

This attribute is not specified in the current version of the 11073-10420 specialization.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE[1]	INT-U16
Type	N/A	N/A	N/A	TYPE[2]	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall[3]	BITS-16
Unit-Code	Body Composition Measurement	Body Composition	Aggregate	OID-Type[4]	INT-U16
Absolute-Time-Stamp	Body Composition Measurement	Body Composition	Aggregate	AbsoluteTime[5]	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Simple-Nu-Observed-Value	Body Composition Measurement	Body Composition	Aggregate	SimpleNuObsValue[6]	FLOAT-Type

Table 59: Numeric Class: Basal Metabolism

Notes:

1. Each metric object is required to have a unique non-zero ID assigned by the implementation.
2. Set to {MDC_PART_SCADA, 57696}. This unit code has been reserved but does not have a Ref ID yet.
3. Set to 0xF040 (mss-avail-intermittent, mss-avail-stored-data, mss-upd-aperiodic, mss-msmt-aperiodic, mss-acc-agent-initiated).
4. Set to MDC_DIM_JOULES.
5. When supported, this value is derived from the Time Stamp field of Body Composition Measurement characteristic. Time Stamp field is present when bit 1 LSB of Flags field in characteristic is set to1. See Section 2.2.6.
6. The Basal Metabolism field of the Body Composition Measurement characteristic has a UINT16 format where each bit represents a value of 1kJ. It is transcoded to FLOAT, by setting the exponent to +3 and attributing the unchanged numeric value from the field to the mantissa.

   If the field value is 0xFFFF (65535), this means that the measurement was unsuccessful and the transcoded FLOAT value should be NaN, indicating that measurement is invalid.

3.5.5.9 MUSCLE PERCENTAGE

This value is optionally transcoded when bit 4 of the Flags field in the Body Composition Measurement is set to 1. Attributes are defined in Table 60.

This attribute is not specified in the current version of the 11073-10420 specialization.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE[1]	INT-U16
Type	N/A	N/A	N/A	TYPE[2]	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall[3]	BITS-16
Unit-Code	Body Composition Measurement	Body Composition	Aggregate	OID-Type[4]	INT-U16
Absolute-Time-Stamp	Body Composition Measurement	Body Composition	Aggregate	AbsoluteTime[5]	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Simple-Nu-Observed-Value	Body Composition Measurement	Body Composition	Aggregate	SimpleNuObsValue[6]	FLOAT-Type

Table 60: Numeric Class: Muscle Percentage

Notes:

1. Each metric object is required to have a unique non-zero ID assigned by the implementation.
2. Set to {MDC_PART_SCADA, 57700}. This unit code has been reserved but does not have a Ref ID yet.
3. Set to 0xF040 (mss-avail-intermittent, mss-avail-stored-data, mss-upd-aperiodic, mss-msmt-aperiodic, mss-acc-agent-initiated).
4. Set to MDC_DIM_PERCENT.
5. When supported, this value is derived from the Time Stamp field of Body Composition Measurement characteristic. Time Stamp field is present when bit 1 LSB of Flags field in characteristic is set to1. See Section 2.2.6.
6. The Muscle Percentage field of the Body Composition Measurement characteristic has a UINT16 format where each bit represents a value 0.1%. It is converted to FLOAT by setting the exponent to -1 and attributing the unchanged numeric value from the field to the mantissa.

   If the field value is 0xFFFF (65535), this means that the measurement was unsuccessful and the transcoded FLOAT value should be NaN, indicating that measurement is invalid.

3.5.5.10 MUSCLE MASS

This value is optionally transcoded when bit 5 of the Flags field in the Body Composition Measurement is set to 1. Attributes are defined in Table 61.

This attribute is not specified in the current version of the 11073-10420 specialization.

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Bluetooth Service	Bluetooth Data Type	11073-20601 Attribute Type (ASN.1)	11073-20601 Data Type (informative)
Handle	N/A	N/A	N/A	HANDLE[1]	INT-U16
Type	N/A	N/A	N/A	TYPE[2]	(INT-U16, INT-U16)
Metric-Spec-Small	N/A	N/A	N/A	MetricSpecSmall[3]	BITS-16
Unit-Code	Body Composition Measurement	Body Composition	Aggregate	OID-Type[4]	INT-U16
Absolute-Time-Stamp	Body Composition Measurement	Body Composition	Aggregate	AbsoluteTime[5]	(INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8, INT-U8)
Simple-Nu-Observed-Value	Body Composition Measurement	Body Composition	Aggregate	SimpleNuObsValue[6]	FLOAT-Type

Table 61: Numeric Class: Muscle Mass

Notes:

1. Each metric object is required to have a unique non-zero ID assigned by the implementation.
2. Set to {MDC_PART_SCADA, 57704}. This unit code has been reserved but does not have a Ref ID yet.
3. Set to 0xF040 (mss-avail-intermittent, mss-avail-stored-data, mss-upd-aperiodic, mss-msmt-aperiodic, mss-acc-agent-initiated).
4. This value is mapped from Bit 0 LSB of Flags field of the Body Composition Measurement characteristic. The mapping is as follows in Table 62:

11073-10420 Mass Unit Value	Bluetooth Measurement Units bit value	Mass Unit Description
MDC_DIM_KILO_G	0	Kilogram
MDC_DIM_LB	1	Pound

Table 62: Mass Type Description Conversion

5. When supported, this value is derived from the Time Stamp field of Body Composition Measurement characteristic. Time Stamp field is present when bit 1 LSB of Flags field in characteristic is set to1. See Section 2.2.6.
6. The Muscle Mass field of the Body Composition Measurement characteristic has a UINT16 format where each bit represents a value of 0.005kg when the unit is set to kg, and 0.01lb when the unit is set to lb. Therefore if the unit is set to kg and the field value is e.g. 16000, this equates to a mass of 80.000 kg (16000 x 0.005). Similarly, if the unit is set to lb and the field value is e.g. 16000, this equates to a mass of 160.00lb (16000 x 0.01).

   To convert this to a FLOAT, the exponent is selected according to the value of the Mass Measurement Resolution bits (see section 3.5.3 for details) and the mass measurement unit (i.e. kg or lb). The mantissa is scaled according to the exponent. For example, if unit is kg and the measurement is 80kg (field value of 16000), and scale resolution is 0.01kg, the exponent is set to -2 and the mantissa is set to 8000 (16000 x 0.005 x $10^{(-2)}$).

In another example, if unit is lb and measurement is 160lb (field value of 16000) and scale resolution is 0.1lb, the exponent is set to -1 and the mantissa is set to 1600 (16000 x 0.01 x $10^{-(-1)}$).

If the field value is 0xFFFF (65535), this means that the measurement was unsuccessful and the transcoded FLOAT value should be NaN, indicating that measurement is invalid.

3.5.5.11 USER ID

User ID is present in Body Composition Measurement when bit 1 of Flag fields is equal to 1.

The 11073-20601 Person-ID is of type INT-U16, while the User ID from the Body Composition Measurement characteristic is one octet, unsigned. When the User ID is in range 0x00 to 0xFE, conversion shall keep the numeric value. For example, User ID 0x02 would be transcoded to Person-ID 0x0002, and 0x85 would be transcoded to 0x0085.

When the User ID is 0xFF (unknown or guest user) it shall be transcoded to 0xFFFF (unknown-person-id).

The use and interpretation of the Person ID in 11073-20601 is implementation-specific. Depending upon the implementation, if the User-ID is absent in the characteristic value it may be ignored or transcoded to the unknown-person-id (0xFFFF).

3.5.5.12 MULTIPLE PACKET MEASUREMENT FLAG

The bit 12 in Flags field in Body Composition Measurement, when is equal to 1, informs that the measurement data is being sent in two pieces (i.e. two consecutive indications).

- Both first and second indications have the bit 12 equal to 1;
- The second indication contains the optional fields that did not fit in the first indication but belong to the same measurement. The respective bits in Fields flag are set accordingly;
- If the service supports Time Stamp and/or User ID, these fields are present only in the first indication;
- The mandatory Body Fat Percentage field is present in both indications, containing the same value.

The transcoder should detect the multiple-packet flag, wait for the second indication and handle the pair of indications as if it were a single-packet measurement.

4. End-To-End Example

This section provides an example of an end-to-end communication between a GATT-based Bluetooth Health Thermometer and a Collector (e.g., phone) implementing an 11073-20601 Manager and a transcoder. This section also describes how Bluetooth characteristic data can be mapped to 11073-20601 nomenclature and modeling. This example illustrates the steps required to use the mappings so that the transcoder can generate 11073-20601 DIM objects based on the received data.

Hypothetical Health Thermometer data is used in Section 4.1 as an input. Section 4.3 discusses how this data could be mapped into 11073-20601 objects.

4.1 HEALTH THERMOMETER DATA

Table 63 and Table 64 describe the Health Thermometer data being sent to the Collector, which implements a Transcoder. The Health Thermometer Bluetooth Address is 00:23:6C:AF:BD:F4.

Health Thermometer Service Data

This data refers to a previous time-stamped measurement taken from a general body location. The values shown represent the sequence of bytes as transmitted on the wire (over the air).

Bluetooth Characteristic	Bluetooth Value
Temperature Measurement	37.0 degrees Celsius with Timestamp of 18th December 2010 15:00:00: 0x02 0x72 0x01 0x00 0xFF 0xDA 0x07 0x0C 0x12 0x0F 0x00 0x00
Temperature Type	Body: 0x02
Intermediate Temperature	Not transcoded to 11073-20601. (Could be if one wanted to use the Measurement-Status attribute and set the status to measurement in progress or something else appropriate)
Measurement Interval	Not transcoded to 11073-20601. (This behavior is implicit in the time stamp)
Valid Range descriptor	Not transcoded to 11073-20601. (In 11073-20601 values exceeding this descriptor would be reported using the ‘not at this resolution’ or via the Measurement-Status attribute.)

Table 63: Health Thermometer Service Data

Note that GATT employs little-endian representation of integers, and the year 2010 (0x07DA in hex) is encoded as 0xDA 0x07 in the Temperature Measurement characteristic, because the year is a 16-bit unsigned integer field. The other date and time fields (month, day, hour, etc.) are all 8-bit values and not affected by endianness.

Also, the FLOAT representation of temperature is affected by endianness. The temperature measurement (37.0 degrees, raw FLOAT value is 0xFF000172) is encoded as 0x72 0x01 0x00 0xFF in the Temperature Measurement characteristic.

Device Information Service Data

This data refers to a Health Thermometer that has its System ID filled in based on its Bluetooth address as described in the characteristic definition accessible via the Bluetooth SIG Assigned Numbers [3].

Bluetooth Characteristic	Bluetooth Value
System ID	0xF4 0xBD 0xAF 0xFE 0xFF 0x6C 0x23 0x00
Model Number String	“TS-1017”
Manufacturer Name String	“ACME”
Serial Number String	“237495-3282-A”
Firmware Revision String	“1.23”
Hardware Revision String	“1.0”
Software Revision String	“1.2”
IEEE 11073-20601 Regulatory Certification Data List	For an example on how to populate this structure, refer to Section 2.2.5.

Table 64: Device Information Service data

System ID is another field affected by the little-endian format of GATT. The actual System ID of this example is 00:23:6C:FF:FE:AF:BD:F4. The System ID characteristic format is (uint40, uint24), for manufacturer identifier and OUI, respectively.

Since the Thermometer of this example attributes timestamps to measurements, it has to expose the internal clock as the Current Time characteristic in Current Time Service (see section 2.2.4, subtopic “Date and Time”, and section 2.2.6 for details). The characteristic has 10 bytes but only the first 7 are of interest for transcoding.

Bluetooth Characteristic	Bluetooth Value
Current Time characteristic	18th December 2010 15:23:06 encoded as 0xDA 0x07 0x0C 0x12 0x0F 0x17 0x06 0xXX 0xXX 0xXX

4.2 HEALTH THERMOMETER SERVICE RECORD

Table 65 shows the Health Thermometer Service record and the attributes contained on the Sensor..

Bluetooth Attribute	Bluetooth Attribute Value	Description
Primary Service (0x2800)	**0x180A**	**Device Information Service**
Characteristic (0x2803)	{0x02, 0xhhhh, 0x2A23}	Characteristic value is Read, Value Handle reference is 0xhhhh, and characteristic is "System ID"
System ID (0x2A23)	{0x00236CFFFEAFBDF4}	System ID
Characteristic (0x2803)	{0x02, 0xhhhh, 0x2A29}	Characteristic value is Read, Value Handle reference is 0xhhhh, and characteristic is "Manufacturer Name String"
Manufacturer Name String (0x2A29)	{0x41, 0x43, 0x4D, 0x45}	Manufacturer Name String = UTF-8 String "ACME"
Characteristic (0x2803)	{0x02, 0xhhhh, 0x2A24}	Characteristic value is Read, Value Handle reference is 0xhhhh, and characteristic is "Model Number String"
Model Number String (0x2A24)	{0x54, 0x53, 0x2D, 0x31, 0x30, 0x31, 0x37}	Model Number String = UTF-8 String "TS-1017"
Characteristic (0x2803)	{0x02, 0xhhhh, 0x2A25}	Characteristic value is Read, Value Handle reference is 0xhhhh, and characteristic is "Serial Number String"

Bluetooth Attribute	Bluetooth Attribute Value	Description
Serial Number String (0x2A25)	{0x32, 0x33, 0x37, 0x34, 0x39, 0x35, 0x2D, 0x33, 0x32, 0x38, 0x32, 0x2D, 0x41}	Serial Number String = UTF-8 String "237495-3282-A"
Characteristic (0x2803)	{0x02, 0xhhhh, 0x2A26}	Characteristic value is Read, Value Handle reference is 0xhhhh, and characteristic is "Firmware Revision String"
Firmware Revision String (0x2A26)	{0x31, 0x2E, 0x32, 0x33}	Firmware Revision String = UTF-8 String "1.23"
Characteristic (0x2803)	{0x02, 0xhhhh, 0x2A27}	Characteristic value is Read, Value Handle reference is 0xhhhh, and characteristic is "Hardware Revision"
Hardware Revision String (0x2A27)	{0x31, 0x2E, 0x30}	Hardware Revision String = UTF-8 String "1.0"
Characteristic (0x2803)	{0x02, 0xhhhh, 0x2A28}	Characteristic value is Read, Value Handle reference is 0xhhhh, and characteristic is "Software Revision String"
Serial Number String (0x2A28)	{0x31, 0x2E, 0x32}	Software Revision String = UTF-8 String "1.2"
Primary Service (0x2800)	**0x1809**	**Health Thermometer Service**
Characteristic (0x2803)	0x20, 0xhhhh, 0x2A1C	Characteristic value is Indicated, Value Handle reference is 0xhhhh and characteristic is "Temperature Measurement"
Temperature Measurement (0x2A1C)	{0x02, 0xFF000172, 0x07DA 0x0C 0x12 0x0F 0x00 0x00}	Timestamp [18th December 2010 15:23:06] Temperature Measurement of 37.0 degrees in Celsius

Table 65: Health Thermometer Service Record

4.3 11073-20601 OBJECTS

Table 66 and Table 67 describe how data are represented as 11073-20601 objects.

MDS Object

11073-20601 Attribute	Bluetooth Equivalent Characteristic	11073-20601 Value	Reference
Handle	None	0	
System-Model	Model Number String	"TS-1017" [1]	Section 2.2.4 – System Model
	Manufacturer Name String	"ACME"	
System-Id	System ID	0x00 0x23 0x6C 0xFF 0xFE 0xAF 0xBD 0xF4	Section 2.2.4 – System Id
Dev-Configuration-Id	None	MDC_TEMP_BODY = 0x4002	Section 3.1.1
Production-Specification	Serial Number String	"237495-3282-A" [1]	Section 2.2.4 – Prod. Specification
	Hardware Revision String	"1.0" [1]	

11073-20601 Attribute	Bluetooth Equivalent Characteristic	11073-20601 Value	Reference
	Software Revision String	"1.2" [1]	
	Firmware Revision String	"1.23"	
Date-and-Time	Current Time	0x20 0x10 0x12 0x18 0x15 0x23 0x06 0x00	Section 2.2.6
Reg-Cert-Data-List	IEEE 11073-20601 Regulatory Certification Data List	For an example on how to populate this structure, refer to Section 2.2.5.	Section 2.2.4 – Reg-Cert-Data-List
System-Type-Spec-List	None	{MDC_DEV_SPEC_PROFILE_TEMP, 1}	

Table 66: MDS Object for Health Thermometer

Notes:

1. Because this is an odd-sized string, a zero (0x00) byte must be appended to its end and its length field must be incremented. See Section 2.2.3 for more information.

Numeric Object

11073-20601 Attribute	Bluetooth Equivalent Characteristic	Value	Reference
Handle	None	1	
Type	None	MDC_PART_SCADA	Section 3.1.1
	None	MDC_TEMP_BODY	
Metric-Spec-Small	None		
Measurement-Status	None	relevant data, 0x10 (optional)	
Metric-Id	None	MDC_TEMP_BODY = 0x4002	Section 3.1.2
Metric-Id-List	None		
Metric-Id-Partition	None		
Unit-Code	Temperature Measurement	MDC_DIM_DEGC	Section 3.1.2
Attribute-Value-Map	None		
Absolute-Time-Stamp	Temperature Measurement	0x20 0x10 0x12 0x18 0x15 0x00 0x00	Section 3.1.2
Measure-Active-Period	None		
Simple-Nu-Observed-Value	None	0xFF000172 (37.0)	Section 3.1.2 and Annex F.8 of [1]
Compound-Simple-Nu-Observed-Value	None		
Basic-Nu-Observed-Value	None		
Compound-Basic-Nu-Observed-Value	None		
Nu-Observed-Value	Temperature Measurement		
Compound-Nu-Observed-Value	None		
Accuracy	None		

Table 67: Numeric Object for Health Thermometer

5.Acronyms and Abbreviations

Acronyms and Abbreviations	Meaning
11073-20601	The ISO/IEEE 11073-20601 standard [1]
APDU	Application Protocol Data Unit
ASCII	American Standard Code for Information Interchange as defined in ISO/IEC 646 (1991)
ASN.1	Abstract Syntax Notation One
BCD	Binary-Coded Decimal
BMI	Body Mass Index
CTS	Current Time Service
DIM	Domain Information Model
DIS	Device Information Service
EUI	Extended Unique Identifier
FDA	Food and Drug Administration
GATT	Generic Attribute Profile
ID	Identifier
IEC	International Electrotechnical Commission
IEEE	Worldwide technical society which generated the IEEE 11073 series standards, www.ieee.org
IG	Interoperability Guidelines
ISO	International Organization for Standardization
LE	Low Energy
LSB	Least Significant Bit
MAP	Mean Arterial Pressure
MDS	Medical Device System
MSB	Most Significant Bit
OID	Object Identifier
OUI	Organizationally Unique Identifier
RACP	Record Access Control Point
USB	Universal Serial Bus
UTF-8	Unicode Transformation Format-8
UUID	Universally Unique Identifier

Table 68: Acronyms and Abbreviations

6.References

[1] ISO/IEEE Std 11073-20601™- 2008 Health Informatics - Personal Health Device Communication - Application Profile - Optimized Exchange Protocol - version 1.0.This also includes ISO/IEEE Std 11073-20601a™-2010 – Amendment 1

[2] Device Information Service v1.1

[3] Bluetooth SIG Assigned Numbers

[4] ISO/IEEE Std 11073-10408™-2008 Standard for Health informatics - Personal health device communication - Device specialization - Thermometer

[5] Health Thermometer Service v1.0

[6] Continua Design Guidelines 2015 (version 5.0)

[7] IEEE Std 11073-10406™-2011 Standard for Health informatics - Personal health device communication - Device specialization - Basic Electrocardiograph (ECG) (1 to 3-lead ECG)

[8] Heart Rate Service v1.0

[9] Blood Pressure Service v1.0

[10] IEEE Std 11073-10407™-2008 Standard for Health informatics – Personal health device communication – Device specialization – Blood Pressure Monitor

[11] IEEE Std 11073-10417™-2011 Standard for Health informatics – Personal health device communication – Device specialization – Glucose meter

[12] Glucose Service v1.0

[13] Bluetooth Core Specification v4.0 or later

[14] Current Time Service v1.1

[15] ISO/IEEE Std 11073-10441™-2008 Standard for Health Informatics – Personal health device communication – Device specialization – Cardiovascular fitness and activity monitor

[16] Specification of Regulatory Certification Data List at ISO/IEEE Std 11073-20601a-2010, sections 6.3.2.3 (MDS class attributes) and A.11.2 (MDS-related data types).

[17] Patient Care Device (PCD) Technical Framework at the IHE site.

[18] Weight Scale Service v1.0

[19] Body Composition Service v1.0

[20] ISO/IEEE Std 11073-10415™-2010 Standard for Health Informatics – Personal health device communication – Device specialization – Weighing Scale

[21] ISO/IEEE Std 11073-10420™-2010 Standard for Health Informatics – Personal health device communication – Device specialization – Body Composition Analyzer