HEALTH DEVICE PROFILE

iWRAP APPLICATION NOTE

Tuesday, 02 October 2012

Version 3.4

bluegiga

VERSION HISTORY

Version	Comment
1.0	First version
1.1	IEEE 11073 chapter added
1.2	iWRAP section added
1.3	Chapter 5 finalized
1.4	Updated IEEE DDS specifications
1.5	HDP sink/source configuration updated
1.6	Added HDP agent instructions, new SDP instructions, new SET PROFILE HDP format
1.7	Examples added
1.8	Omron BPM example added
1.9	IEEE agent mode description and examples added for BPM and BGM.
2.0	Spelling errors fixed
2.1	Updated to match iWRAP 3.1.0 build 357 features
2.2	Updated to match iWRAP 3.1.0 build 358 features
2.3	Extended configuration description updates
2.4	Chapter 8.1 updated
2.5	Pulse Oximeter example added
2.6	Standard configuration ID for weight scale fixed
2.7	Health Thermometer added
2.8	SetTime documentation added
2.9	Improved examples added. IEEE specification status updated. Note about Bluetooth and Continua compliance updated.
3.0	Manual IEEE association added
3.1	Added MDL management and updatable IEEE attributes

3.2	Updated recommended firmware version
3.3	Body Composition Analyzer added

TABLE OF CONTENTS

1 Introduction

This application note discusses *Bluetooth* Health Device Profile (HDP), describes its advantages and how it can be utilized. Also practical examples are given how the HDP is used with the iWRAP firmware.

1.1 Background

Bluetooth is used in a variety of medical applications as a secure and reliable connection method. Typically the implementations have been based on *Bluetooth* Serial Port Profile (SPP) and manufacturer specific proprietary implementations and protocols. Therefore different implementations have had a poor level of interoperability with each other.

For this reason the *Bluetooth* SIG formed the Medical Device Working Group (MED WG) and set a goal to develop a profile that would introduce interoperability between different medical sensors (sources) and collecting devices (sinks) from different manufacturers. The work resulted Multi-channel Adaptation Protocol (MCAP) and the *Bluetooth* Health Device Profile (HDP), which were adopted during 2008.

The application level interoperability is provided by ISO/IEEE 11073-20601 Personal Health Data Exchange Protocol and IEEE 11073-104xx device specializations.

1.2 Use cases

HDP is mainly targeted to supporting variety of in-home or in-hospital applications. The most typical use cases are different portable sensors like ECG transmitters, blood glucose level meters or blood pressure meters that transmit the measurements in the hospital to a monitoring PC. In an in-home application the measurements the from sensors could be transmitted to a gateway device that forwards the information to remote servers for further processing.
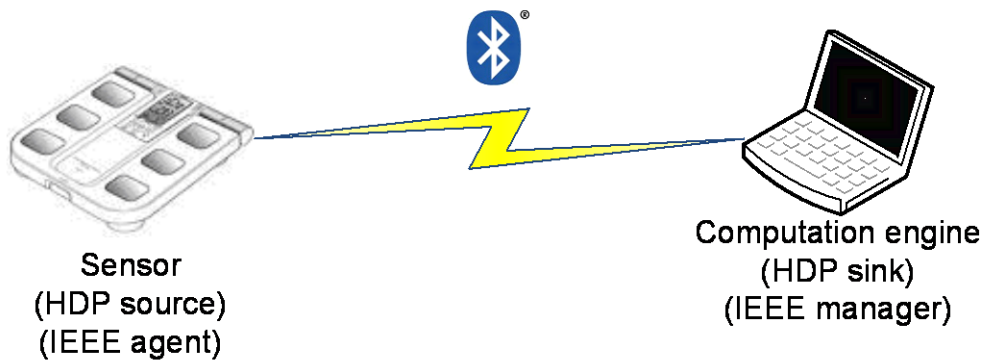
Figure 1: Use case 1
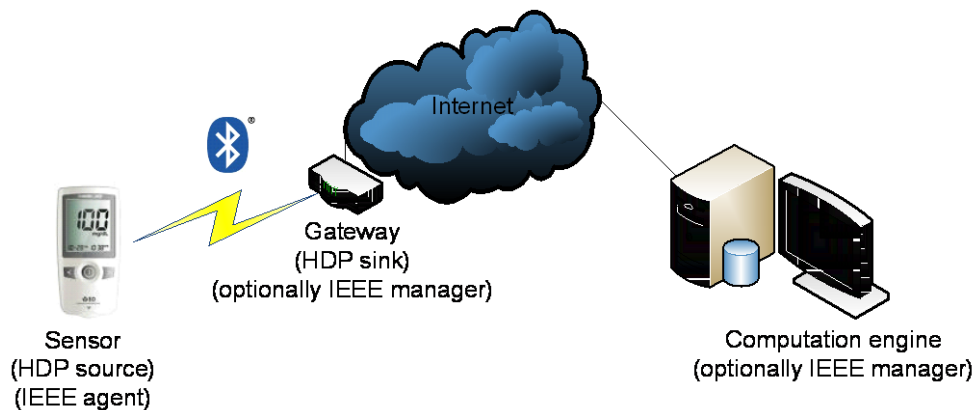
Figure 2: Use case 2

1.3 Advantages of HDP

Medical, Healthcare and Fitness Applicability

HDP is a specialized profile designed to allow for interoperability between medical, healthcare and fitness applications from different vendors. This gives HDP a significant advantage over more generic profiles like Serial Port Profile, or others that only provide a base layer for proprietary protocols and data formats.

Wireless Service Discovery

HDP provides a standard wireless discovery method where a device's device-type and supported application data-type is determined. This discovery occurs by using the Generic Access Profile (GAP) discovery procedures and the Service Discovery Protocol (SDP).

Reliable Connection-oriented behavior

HDP uses the connection oriented capability of the *Bluetooth* lower layers to ensure more reliable behavior when a *Source* moves out of range or disconnects (either inadvertently or intentionally). This allows both *Source* and *Sink* to recognize that the link has been broken, and to take appropriate actions.

Additionally, the Reliable Data Channel deals with the detection and retransmission of packets corrupted by interference on the radio link. The Frame Check Sequence (FCS), which is optional for L2CAP, is particularly important when operating with high interference levels such as being near Wi-Fi or other ISM band devices.

Reliable Control Channel

The HDP Control Channel uses Enhanced Retransmission Mode for improved reliability desired for signaling commands.

Support for Flexible Data Channel configurations

HDP Data Channels allow for independent configuration as this provides flexibility to the applications. Data Channels configured as 'reliable' use Enhanced Retransmission Mode, while data channels configured as 'streaming' use Streaming Mode. The use of FCS is optional for Data Channels and mandatory for the Control Channel.

Application-level Interoperability

HDP, along with the ISO/IEEE 11073-20601 Optimized Exchange Protocol, provides a structured approach for the establishment of Control and Data Channels to allow for information exchange between the communicating health devices. As device specializations are added in ISO/IEEE 11073-104XX and adopted by the MED WG, the *Bluetooth* Assigned Numbers document allow for the addition of the adopted specializations without having to update the HDP specifications..

Efficient Reconnection mechanism

HDP allows devices to retain the state of the system and eliminates redundant configuration steps upon reconnection. This procedure allows devices to disconnect while there is no receiving or transmitting of data, and then reconnect as data becomes available. This method reduces average power consumption.

High resolution clock synchronization

HDP also defines an optional Clock Synchronization Protocol (CSP) that allows for precise timing synchronization (note: theoretically in the microsecond range) between health devices. This feature is for health devices, such as high-speed sensors, that require close synchronization.

Optimized for devices with low resources

HDP has a small set of simple control commands and makes it relatively inexpensive to implement. It is also possible for devices to support an even smaller subset of the available commands depending on the role of the device and individual application requirements. This is helpful for product requirements defining limited code and memory space.

Source: [1]

2 IEEE 11073-20601 Specification

The IEEE 11073-20601 Optimized Exchange Protocol provides a framework of object-oriented information modeling, information access and measurement data transfer suitable to a wide variety of personal health devices. Examples of such health devices are as follows: weight scales, thermometers, pulse oximeters, blood pressure monitors, and glucose meters. On addition the protocol is designed to support a range of home health sensors. The goal of IEEE 11072-20601 is to enable interoperability between sensors and data management devices to process, display or transfer the specific measurements. IEEE 11073-20601 protocol is designed for use with transports such as *Bluetooth* and USB.

The ISO/IEEE 11073 specifications contains the 20601 Core protocol specification describing the tools to represent and convey data and a set of Device Data Specializations, which contains details how 20601 is applied to a specific health device. At the time of writing this document the following Device Data Specializations existed:

- IEEE 11073-10404 – Pulse Oximeter
- IEEE 11073-10407 – Blood Pressure Monitor
- IEEE 11073-10408 - Thermometer
- IEEE 11073-10415 – Weighing Scale
- IEEE 11073-10417 – Glucose Meter
- IEEE 11073-10441 – Cardiovascular Fitness and Activity Monitor
- IEEE 11073-10442 – Strength Fitness Equipment
- IEEE 11073-10471 – Independent Living Activity Hub

Source: [1]

Data exchange specification	Document number	Document name
0x01	ISO/IEEE 11073-20601	Health informatics - Personal health device communication - Application profile - Optimized exchange protocol

Table 1: Data exchange specifications

Note: All other values reserved

Data type	MDEP Data type	IEEE Standard
Pulse oximeter	0x1004 (4100 decimal)	IEEE Std 11073-10404
Blood pressure monitor	0x1007 (4103 decimal)	IEEE Std 11073-10407
Body thermometer	0x1008 (4104 decimal)	IEEE Std 11073-10408
Body weight scale	0x100F (4111 decimal)	IEEE Std 11073-10415
Glucose meter	0x1011 (4113 decimal)	IEEE Std 11073-10417
Step counter based on 10441	0x1068 (4200 decimal)	IEEE Std 11073-10441

Cardiovascular Fitness and Activity Monitor	-	IEEE Std 11073-10441
Strength Fitness Equipment	-	IEEE Std 11073-10442
Independent Living Activity Hub	-	IEEE Std 11073-10471
Body composition analyzer	-	IEEE Std 11073-10420
Peak flow	-	IEEE Std 11073-10421
Medication monitor	-	IEEE Std 11073-10472

Table 2: HDP device data specializations

Note: All other values reserved.

Reference: [2]

Standards under development

- IEEE P11073-10406™ - Device specialization - Basic ECG (1 to 3-lead)

- IEEE P11073-10413™ - Device specialization - Respiration rate monitor

- IEEE P11073-10418™ - Device specialization - INR (blood coagulation)

- IEEE P11073-10419™ - Device specialization - Insulin pump

3 Transfer of Measurement Data over HDP

Before describing the steps involved in conveying measurement data, the terminology used requires some definition. HDP defines a Source to be a transmitter of medical application data, and 20601 uses the term Agent for the node that transmits personal health data. Similarly, HDP's notion of a Sink is essentially that of the 20601 Manager. When discussing about HDP terms source and sink are used and when discussing about 20601 Agent and Manager are used.

Some more detailed introduction to HDP is also needed. HDP provides two types of connections:

- Control channels - This is used to negotiate data channel parameters, and setting up the data channel(s).

- Data channels – Data channels are used for the actual data 11073-xxxxx) transmission. Two types of data channels exists:

  1. Reliable data channels

  2. Streaming data channels

Either a Source or a Sink may initiate a connection by first establishing a control channel. After the control channel is established, it is used to negotiate and establish one or more data channels. As said earlier two types of data channels can be set up: reliable and streaming data channels. Reliable data channels are appropriate for transmitting measurement or alert information where the confidence in the exchange is at its highest and streaming data channels are useful when the timeliness is a higher priority than the reliable delivery of every frame so for example when sending wave form data where small data losses can occasionally occur.

Once the MCAP Data Link (MDL) has been established, a connection indication is sent to the 11073-20601 application layer. This initiates a series of transactions defined by connection state machines within the Agent and Manager. The first step involves the Agent sending an Association Request message, which includes a high-level description of itself to the Manager.

If the Manager does not wish to communicate with the Agent, it will reply with an Association Response message with a rejection status code. On the other hand, if the Manager deems it appropriate to continue the Association, it will respond in one of two ways.

1. If the Manager has previously communicated with this device, or it has been programmed to understand the collection of objects, attributes and data transmission details (e.g. "standard configuration"), then the Manager will respond by accepting the association, at which point the Agent and Manager are considered to be in the Operating state.

2. If the Manager is not familiar with enough details of the Agent's implementation, then the Manager will accept the association, but will ask that the Agent describe its implementation by means of a Configuration process.

Note: The association traffic is on the first Reliable Data Channel (per MCL) and each MCL must have its own "first Reliable Data Channel" for its association traffic. Recommended but not required, the confirmed event traffic should be on the first Reliable Data Channel as well. For multiple device specializations when supported by a device, it is also recommended to associate to them at the same time as opposed to sequentially as if they are physically separate devices.

The Operating state is where measurement data transfer may occur. This transfer occurs through a number of methods, each of which may be suitable for a different style of communication.

Either the Manager or Agent may initiate data transfer. If the Manager initiates data transfer, then it may do so by:

1. Asking the Agent for a single measurement, if available, or

2. Telling the Agent that it may transfer data for a fixed period of time, or

3. Controlling the Agent's transmission of data using explicit Start and Stop commands.

When either the Agent or the Manager terminates an association, it may do so by issuing an Association Release Request. The device on the other end of the link responds with an Association Release Response. At this point, the 20601 layer informs HDP to disconnect the communications link. Another means of terminating an association, not shown here, is by means of an Association Abort. There is no required response from such a transmission.

The 20601 protocol intends for asymmetric device architectures. Agents, by design, intend to measure health data. Their function is not to be a data processor, network device or timekeeper. Computation complexity transfers to the Manager whenever possible. This allows Agents to be small, inexpensive and simple.

Agents typically do not intend to communicate with each other, but rather each Agent communicates with a single Manager. The Manager communicates with multiple Agents and coordinates activities as in cases where the Manager coordinates precise measurement of physiological phenomena detected by distinct Agents.

The 20601 protocol provides a number of facilities to transfer a combination of discrete numeric data, sampled waveform data as well as the ability for the Agent to store data that had been collected over a long period of time and forward that information when requested by the Manager.

A Scanner data construct is able to collect discrete Numeric and waveform data objects and combine them into a single packet for transmission. This allows efficient transmission of Streaming data, since the overhead of support information accompanying multiple data objects reduces by only sending the support information of a single packet.

In several use cases, such as sleep studies, it may be more practical to defer transmitting measurements for several hours, or until several sessions' worth of data have been collected. In order to accommodate the needs of such use cases, 20601 defines models to store, describe the structure of, and transfer data.

HDP and 20601 can support Agents providing multiple types of measurements (i.e. pulse oximeters and blood pressure monitors), because constructs within the data exchange layer allow the description of multiple Device Specializations. Since HDP provides for the establishment of multiple data channels, it is possible to transfer each function's measurements across a dedicated data channel. It would also be possible to partition the channels so that the Agent could transfer the discrete numeric data from all functional units across a reliable data channel, and transfer all waveform data across the streaming data channels.

Source: [1]

4 iWRAP: HDP gateway mode

The HDP gateway implementation in the iWRAP firmware is illustrated in the Figure 3. iWRAP as seen in the picture implements the HDP source and HDP sink modes. In the HDP gateway mode the IEEE Agent and Manager implementations are left to the host's responsibility.

The HDP profile is controlled by the host via one or several of iWRAP interfaces. At the moment the main data and command interface is UART, but some commands and events can also be invoked via GPIO pins.
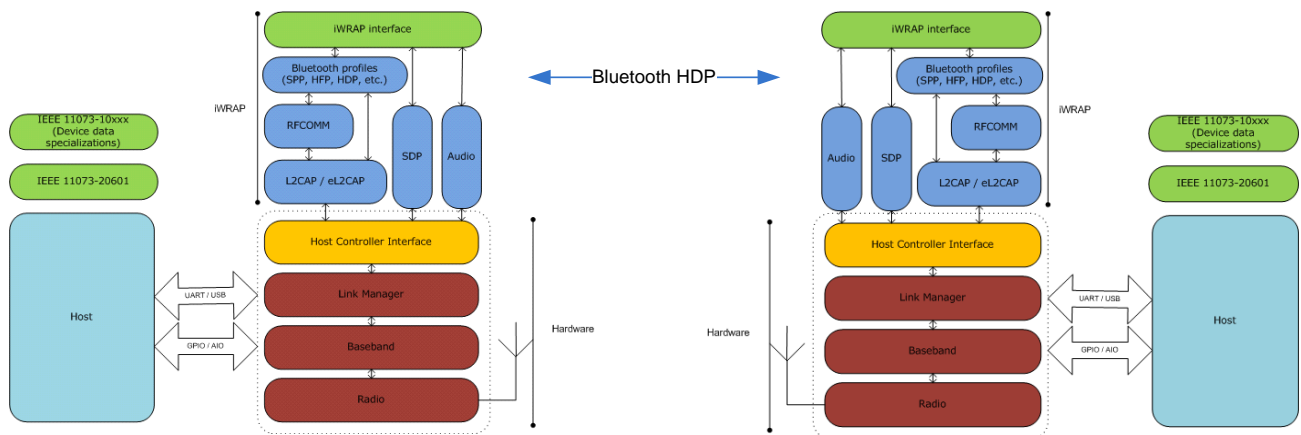
Figure 3: iWRAP HDP architecture

5 iWRAP: IEEE agent mode

The HDP agent implementation in the iWRAP firmware is illustrated in the Figure 3. iWRAP, as seen in the picture, implements the HDP source and one or more IEEE agent(s) as well. This mode allows a lower-end host processor to be used and faster time to market as the IEEE protocol is also implemented in the iWRAP firmware.

The HDP profile and the IEEE agent are controlled by the host via one or several of the iWRAP interfaces. At the moment the main data and command interface is UART, but some commands and events can also be invoked via GPIO pins.
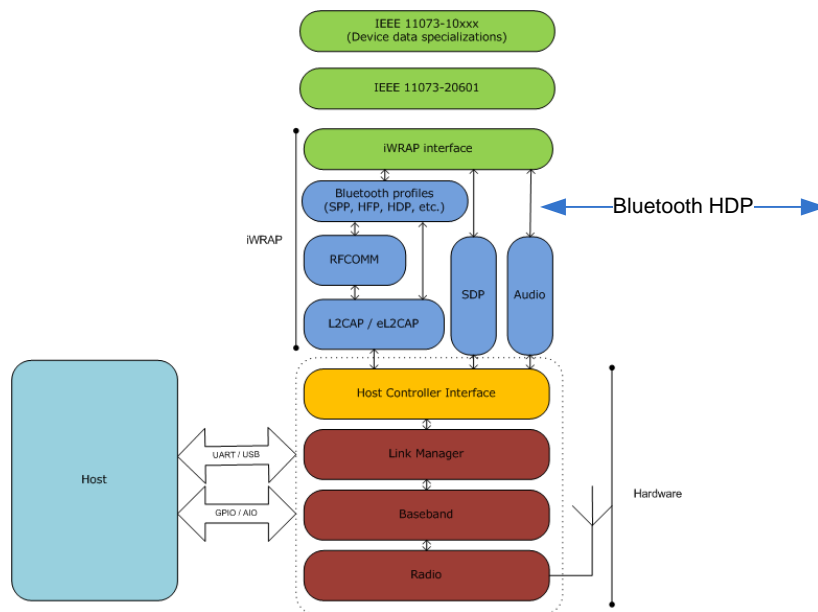
Figure 4: iWRAP IEEE agent architecture

At the moment the following IEEE 11073-104xx Device Data Specializations are supported by the iWRAP IEEE agent firmware:

- IEEE 11073-10407   - Blood Pressure Monitor
- IEEE 11073-10417   - Glucose Meter
- IEEE 11073-10417   - Weight scale
- IEEE 11073 – 10404   - Pulse Oximeter
- IEEE 11073 – 10408   - Thermometer
- IEEE 11073 – 10420   - Body Composition Analyzer

More device data specializations can be added into iWRAP by Bluegiga Technologies.

6 Multi profile operation

iWRAP supports multi profile operation with HDP. This means on addition to HDP also other types of *Bluetooth* connections can be established as well. This can include for example *Bluetooth* Serial Port Profile (SPP), Hands-Free Profile (HFP) or Dial-Up Networking (DUN). At the moment iWRAP supports the following *Bluetooth* profiles:

- Serial Port Profile (SPP) / DevA and DevB

- Hands-Free Profile (HFP) v.1.5 / HFP and HFP-AG modes

- Headset Profile (HSP) v.1.2 / HSP and HSP-AG modes

- Dial-up Networking Profile (DUN) / Terminal emulation

- OBEX Object Push Profile (OPP) / OPP Server and Client

- OBEX File Transfer Profile (FTP) / FTP Client

- Phone Book Access Profile (PBAP) / PCE mode

- Human Interface Device (HID) / HID device

- Advanced Audio Distribution Profile (A2DP) / Sink and Source modes

- A/V Remote Control Profile (AVRCP) / AVRCP Controller and Target

- Device Identification Profile (DI)

- Health Device Profile (HDP) v1.0 / Source and Sink modes

7 Using HDP Gateway mode

This chapter instructs the HDP usage and configuration with the iWRAP firmware.

NOTE: The application note assumes that the following version of iWRAP firmware is used: iWRAP 5.0.x build 603 or newer.

7.1 Configuration

7.1.1 HDP Sink

HDP sink is enabled with command:

"**SET PROFILE HDP SINK {*mask*} {*service_name*}**"

mask	A bit mask that tells which IEEE device data specializations are supported.
	Bit 0 – Pulse oximeter
	Bit 1 – Blood pressure meter
	Bit 2 - Thermometer
	Bit 3 – Weighing scale
	Bit 4 – Glucose meter
	Bit 5 – Cardiovascular fitness and activity monitor
	Bit 6 – Strength fitness equipment
	Bit 7 – Independent living activity hub
	Bit 8 – Body composition analyzer
service_name	This parameter configures user friendly description of the device. Special characters are not allowed. White spaces may be used, if parameter is enclosed in double quotes.

Bluetooth Health Device Profile requires that the IEEE data is encapsulated into a single *Bluetooth* packet. Therefore with iWRAP the MUX mode must be used. The MUX mode is enabled with command:

"**SET CONTROL MUX 1**"

For pairing with other *Bluetooth* enabled devices the *Bluetooth* security needs to be configured. *Bluetooth* HDP based devices support *Bluetooth* 2.1 + EDR specification and should also support the Secure Simple Pairing (SSP) mode. In iWRAP the following configurations are needed therefore.

"SET BT SSP 3 0"

"SET BT AUTH * <pin>"

Finally a reset is needed to for the HDP profile to become active.

Below is an example how to enable HDP sink mode (Blood Pressure monitor) and iWRAP MUX mode.

SET PROFILE HDP SINK 2 Manager	(Enables HDP profile – sink mode)
SET BT SSP 3 0	(Enables SSP "Just works" mode)
SET BT AUTH * 0000	(Set's *Bluetooth* pin code to 0000 for non SSP devices)
SET CONTROL MUX 1	(Enables iWRAP's MUX mode)
¿READY.	(READY encapsulated into a MUX frame)
RESET	(Must be sent using the MUX protocol)

Below is an example how to enable HDP sink mode (Blood Pressure monitor and Body thermometer) and iWRAP MUX mode.

SET PROFILE HDP SINK 6 Manager	(Enables HDP profile – sink mode)
SET BT SSP 3 0	(Enables SSP "Just works" mode)
SET BT AUTH * 0000	(Set's *Bluetooth* pin code to 0000 for non SSP devices)
SET CONTROL MUX 1	(Enables iWRAP's MUX mode)
¿READY.	(READY encapsulated into a MUX frame)
RESET	(Must be sent using the MUX protocol)

7.1.2 HDP Source

HDP source is enabled with command:

"**SET PROFILE HDP SOURCE {*mask*} {*service_name*}**"

mask	A bit mask that tells which IEEE device data specializations are supported.
	Bit 0 – Pulse oximeter
	Bit 1 – Blood pressure meter
	Bit 2 - Thermometer
	Bit 3 – Weighing scale
	Bit 4 – Glucose meter
	Bit 5 – Cardiovascular fitness and activity monitor
	Bit 6 – Strength fitness equipment
	Bit 7 – Independent living activity hub
service_name	This parameter configures user friendly description of the device. Special characters are not allowed. White spaces may be used, if parameter is enclosed in double quotes.

HDP profile requires that the IEEE data is encapsulated into a single *Bluetooth* packet. Therefore with iWRAP the MUX mode must be used. The MUX mode is enabled with command:

"**SET CONTROL MUX 1**"

For pairing with other *Bluetooth* enabled devices the *Bluetooth* security needs to be configured. *Bluetooth* HDP based devices support *Bluetooth* 2.1 + EDR specification and should also support the Secure Simple Pairing (SSP) mode. In iWRAP the following configurations are needed therefore.

"SET BT SSP 3 0"

"SET BT AUTH * <pin>"

The *Bluetooth* class-of-device (CoD) should be set to "medical device" class to reflect the type of the *Bluetooth* device. The CoD is configured with command:

"SET BT CLASS {*cod*}"

Finally a reset is needed to for the HDP profile to become active.

Below is an example how to enable HDP source mode (Blood Pressure monitor) and iWRAP MUX mode.

SET PROFILE HDP SOURCE 2 BluegigaBPM	(Enables HDP profile – source mode)
SET BT SSP 3 0	(Enables SSP "Just works" mode)
SET BT AUTH * 0000	(Set's *Bluetooth* pin code to 0000 for non SSP devices)
SET *BLUETOOTH* CLASS 000904	(Set CoD to Blood Pressure Monitor)
SET CONTROL MUX 1	(Enables iWRAP's MUX mode)
¿READY.	(READY encapsulated into a MUX frame)
RESET	(Must be sent using the MUX protocol)

7.2 Service discovery

Bluetooth Health Device Profile enable wireless service discovery, so you can find out the capabilities the remote device supports. Wireless service discovery uses the *Bluetooth* Service Discovery Profile (SDP).

With HDP profile a special service discovery method needs to be used, the format is as follows:

"**SDP {bd_addr} 1400 ALL**".

bd_addr	*Bluetooth* device address of the remote device.
1400	UUID for *Bluetooth* HDP

Below is an example how to perform a service discovery to a Bluegiga AP3201 eHealth gateway, which implements HDP sink and IEEE manager.

SDP 00:07:80:9a:08:0d 1400 ALL

SDP 00:07:80:9a:08:0d < I 0 I 10000 > < I 1 < U 1402 > > < I PROTOCOLDESCRIPTORLIST < < U L2CAP I **feff** > < U 001e I 100 > > > < I 5 < U BROWSE > > < I 9 < < U 1400 I 100 > > > < I d < < < U L2CAP I **fefd** > < U 001f > > > > < I SERVICENAME S "Bluegiga Technologies HDP service" > < I 101 S "HDP service running on AP3201" > < I 102 S "Bluegiga Technologies Oy" > < I 200 < < I **01** I **1007** I 01 S "BPM" > < I **02** I **100f** I 01 S "Scale" > < I **03** I **1029** I 01 S "Cardio" > < I **04** I **1004** I 01 S "Oxidometer" > < I **05** I **1011** I 01 S "Glucose" > < I **06** I **1008** I 01 S "Thermometer" > < I **07** I **1068** I 01 S "Step counter" > > > < I 301 I 01 > < I 302 I 04 >

SDP

---

feff	= L2CAP psm for HDP control channel
fefd	= L2CAP psm for HDP data channel
01	**=** MDEP ID for blood pressure monitor service
1007	= MDEP data type for blood pressure monitor service
02	**=** MDEP ID for weight scale service
100f	= MDEP data type for weight scale service
03	**=** MDEP ID for Cardiovascular fitness service
1029	= MDEP data type for cardiovascual fitness service
04	**=** MDEP ID for pulse oximeter service
1004	= MDEP data type for pulse oximeter service
05	**=** MDEP ID for blood glucose service
1011	= MDEP data type for blood glucose service
06	**=** MDEP ID for thermometer service
1008	= MDEP data type for thermometer service
07	**=** MDEP ID for step counter service
1068	= MDEP data type for step counter service

7.3 Connection establishment

7.3.1 MCAP Communications Link (MCL) creation

With HDP, first a control channel needs to be established. The control channel is used for various signalling between the HDP sink and HDP source. Such signalling can for example be data channel creation or termination.

The HDP control channel is opened, typical to iWRAP, with a **CALL** command:

"**CALL {*bd_addr*} {*psm*}**".

           bd_addr   *Bluetooth* device address of the remote device.

           psm   L2CAP psm for HDP control channel

Below is an example how to set up a HDP connection from iWRAP HDP gateway to AP3201.

```
CALL 00:07:80:89:56:f6 feff HDP
CALL 0
CONNECT 0 HDP feff
```

7.3.2 MCAP Data Link (MDL) creation

Once the MCL has been set up one data channels can be created.

In iWRAP a MDL is created with command:

"**HDP CREATE {*mdl*} {*mdep*} {*configuration*} {*psm*}"**

mdl	An MCAP Data Link ID. Every data link needs to have a unique ID.
mdep	An MCAP Data End Point (MDEP) ID. Use the MDEP ID found out with SDP. For a generic echo channel use 0.
configuration	Configuration value. 2 = streaming channel 1 = Reliable connection / data channel, 0 = no preference
psm	L2CAP psm for the MDL. Use the L2CAP psm for the data channel found out with SDP.

Here's an example how to set up a single MDL with to from iWRAP HDP gateway to AP3201 and the BPM service. iWRAP automatically opens a 2nd L2CAP connection for the MDL as is seen from the **CONNECT** event.

```
HDP CREATE 1 1 1 fefd
HDP 0 MDL 0001 CONFIG 1
CONNECT 1 HDPDATA fefd
```

Because this is the first MDL, ID 1 is used and BPM service uses the reliable connection instead of streaming channel. L2CAP psm *fefd*.

After the data channel has been successfully created the host can perfrom the IEEE association and data transfer using the MDL connection, which in the above example got *link_id* 1. The IEEE data is sent therefore to the connection with *link_id* 1.

Note: Source must always specify the {configuration} to be streaming or reliable. Sink must always use no preference.

7.3.3 MCAP Data Link (MDL) termination

MDL can be terminated at any point, with iWRAP command:

"**HDP DELETE {*mdl_id*}**"

           mdl_id   MDL ID of the data channel to terminate.

Termination of MDL connection

```
HDP DELETE 1
NO CARRIER 1 ERROR 0
HDP 0 DELETE 0001
```

Note:

- The order of the events may vary

7.3.4 MCAP Communications Link (MCL) termination

The MCL can simply be closed with iWRAP command:

"**CLOSE {*link_id*}**"

           link_id   Link ID of MCL connection

MCL connection termination

```
CLOSE 0
NO CARRIER 0 ERROR 0
```

7.4 Managing MCAP Data Links (MDLs)

7.4.1 List available MDLs

Available MDLs can be listed with iWRAP command:

"**MDL LIST"**

The command returns a list of available MDLs in following format:

"**MDL {index} {bd_addr} {mdl_id} {mdep_id} {configuration} {link_id}**"

If the Bluetooth link of the MDL is down, the "**link_id**" is "**ff**". The list ends with a line containing only "**MDL**".

```
MDL 00 00:07:80:9a:08:07 0001 02 1 ff
MDL
```

7.4.2 Delete specific MDL

Currently connected MDLs may be deleted with "**HDP DELETE**" command. There is a different command, which may be used to delete both connected and disconnected MDLs:

"**MDL DELETE {bd_addr} {mdl_id}**"

```
MDL DELETE 00:07:80:9a:08:07 1
MDL DELETE 00 00:07:80:9a:08:07 0001
```

7.4.3 Reconnect MDL

If the Bluetooth link used by the MDL terminates, e.g. due to link loss, the MDL may be reconnected. The iWRAP command to reconnect the MDL is:

"**HDP RECONNECT {mdl_id} {psm}**"

CALL 00:07:80:9a:08:07 FEFF HDP	(Open MCAP control channel)
CALL 0	
CONNECT 0 HDP feff	
HDP CREATE 1 1 1 FEFD	(Open MCAP data channel)
HDP 0 MDL 0001 CONFIG 1	
CONNECT 1 HDPDATA fefd	
CLOSE 0	(Disconnect Bluetooth link)
NO CARRIER 0 ERROR 0	
NO CARRIER 1 ERROR 0	
CALL 00:07:80:9a:08:07 FEFF HDP	(Open MCAP control channel)
CALL 0	
CONNECT 0 HDP feff	
HDP RECONNECT 1 FEFD	(Reconnect MCAP data channel)
HDP 0 RECONNECT 0001	
CONNECT 1 HDPDATA fefd	

7.5 Data transfer

Once both MCL and MDL have been set up data transfer can be made. The MDL is a transparent data link between the HDP source and HDP sink, very similar to *Bluetooth* Serial Port Profile. However the *Bluetooth* Health Device Profile mandates that the communications is made using the IEEE 11073-xxxxx protocols.

A few points should be noted:

- Data transmission needs to be done using the iWRAPs MUX mode, because:
  - HDP profile mandates that a single IEEE frame is fitted into a single *Bluetooth* packet
  - If MUX mode is not used iWRAP cannot packetize IEEE frames into a single *Bluetooth* packet
- In the HDP gateway mode iWRAP does NOT implement any of the IEEE protocols, but they must be implemented by the host system.

8 Using IEEE agent mode

This chapter explains how to use the iWRAP firmware with IEEE agent mode. Only the HDP source (IEEE agent) side is supported.

NOTE: The application note assumes that the following version of iWRAP firmware is used: iWRAP 5.0.0 build 581.

This firmware version has been tested to pass Continua v.1.5 test cases.

8.1 Configuration

IEEE agent mode is enabled with command:

"**SET PROFILE HDP AGENT {***mask***} {***service_name***} {***manufacturer***} {***model***} [features] [S/N]**"

mask	A bit mask that tells which IEEE device data specializations are supported.
	Bit 0 – Pulse oximeter
	Bit 1 – Blood pressure meter
	Bit 2 - Thermometer
	Bit 3 – Weighing scale
	Bit 4 – Glucose meter
	Bit 5 – Cardiovascular fitness and activity monitor
	Bit 6 – Strength fitness equipment
	Bit 7 – Independent living activity hub
service_name	This parameter configures user friendly description of the device. Special characters are not allowed. White spaces may be used, if parameter is enclosed in double quotes.
manufacturer	This parameter configures the IEEE manufacturer string. Special characters are not allowed. White spaces may be used, if parameter is enclosed in double quotes.
model	This parameter configures the IEEE model string. Special characters are not allowed. White spaces may be used, if parameter is enclosed in double quotes.
features	Features bit mask.
	0001 = When SetTime is enabled, agent requests the manager to set the agents time. (**Optional**)
S/N	Serial number string of the device. Special characters are not allowed. White spaces may be used, if parameter is enclosed in double quotes. (**Optional**)

For pairing with other *Bluetooth* enabled devices the *Bluetooth* security needs to be configured. *Bluetooth* HDP based devices support *Bluetooth* 2.1 + EDR specification and should also support the Secure Simple Pairing (SSP) mode. In iWRAP the following configurations are needed therefore.

"SET BT SSP 3 0"

"SET BT AUTH * <pin>"

Finally a reset is needed to for the HDP profile to become active.

Below is an example how to enable IEEE agent mode for a Blood Pressure monitor.

SET PROFILE HDP AGENT 2 BPM Bluegiga "iWRAP Agent"	(Enables IEEE agent mode)
SET BT SSP 3 0	(Enables SSP "Just works" mode)
SET BT AUTH * 0000	(Set's *Bluetooth* pin code to 0000 for non SSP devices)
SET BT CLASS 000904	(Sets class-of-device for a BPM)
RESET	(Reset is needed to active settings)

Below is an example how to enable IEEE agent mode for a Blood Pressure monitor. If manufacturer or model strings have white spaces then quotation marks need to be used.

SET PROFILE HDP AGENT 2 "B P M" "B G T" "1 2 3"	(Enables IEEE agent mode)
SET BT SSP 3 0	(Enables SSP "Just works" mode)
SET BT AUTH * 0000	(Set's *Bluetooth* pin code to 0000 for non SSP devices)
SET BT CLASS 000904	(Sets class-of-device for a BPM)
RESET	(Reset is needed to active settings)

SDP record name	=	"B P M"
Manufacturer name	=	"B G T"
Model name	=	"1 2 3"

Below is an example how to enable IEEE agent mode for a Blood Pressure monitor and SetTime feature enabled.

SET PROFILE HDP AGENT 2 BPM Bluegiga 1234 0001	(Enables IEEE agent mode)
SET BT SSP 3 0	(Enables SSP "Just works" mode)
SET BT AUTH * 0000	(Set's *Bluetooth* pin code to 0000 for non SSP devices)
SET BT CLASS 000904	(Sets class-of-device for a BPM)
RESET	(Reset is needed to active settings)

8.2 Service discovery

The service discovery is not necessary in the IEEE agent mode, since it's automatically done during the connection establishment, but in case it needs to be done exactly the same approach can be used as in HDP gateway mode, so please refer to chapter 7.2.

8.3 Time configuration

Before the connection can be established the current time needs to be configured into iWRAP. The IEEE specification requires that the agent indicates it's time to the manager during the configuration exchange. The time is configured with the following iWRAP command:

"AGENT SETTIME {*yyyy-mm-ddTHH:MM:SSss*}"

yyyy	Year
mm	month
dd	day of month
HH	hours
MM	minutes
SSss	seconds

Below is an example how to configure the time into iWRAP.

AGENT SETTIME 2010-11-03T20:10:0000

8.4 Connection establishment

The connection establishment is also simplified in the IEEE agent mode and there is no need to separately establish MCL and MDL connections, but simply open the connection using the desired MDEP data type. iWRAP firmware hides the complexity of service discovery and separate MCL and MDL creation. The connection is established with the following command:

"AGENT CALL {*bd_addr*} {*mdep_dt*} [*config_id*]"

> **bd_addr**   *Bluetooth* device address of the remote device.
>
> **mdep_dt**   MDEP data type.
>
> **config_id**   Preferred IEEE configuration ID. **(Optional)**

Below is an example how to set up a HDP connection from iWRAP to AP3201 using the Blood Pressure Monitor service.

AGENT CALL 00:07:80:89:56:f6 1007	(Connection establishment)
CALL 0	(Connection establishement is started)
CONNECT 0 HDP feff	(Successful MCL creation)
HDP 0 MDL 0001 CONFIG 1	
CONNECT 1 HDPDATA fefd	(Successful MDL creation)
AGENT STATE 01 UNASSOCIATED	(Start of IEEE association)
AGENT STATE 03 ASSOCIATING	
AGENT STATE 07 SENDING_CONFIG	(IEEE configuration negotiation)
AGENT STATE 06 WAITING_APPROVAL	
AGENT STATE 05 OPERATING 1007 02bc	(Successful IEEE association)

Once the event **AGENT STATE 05 OPERATING 1007 02bc** is received the agent is ready to send the data reports to the manager. If this state is not reached the association with the manager has failed.

1007 tells the MDEP data type (Blood Pressure Monitor in this case).

02bc tells the IEEE configuration the manager has approved.
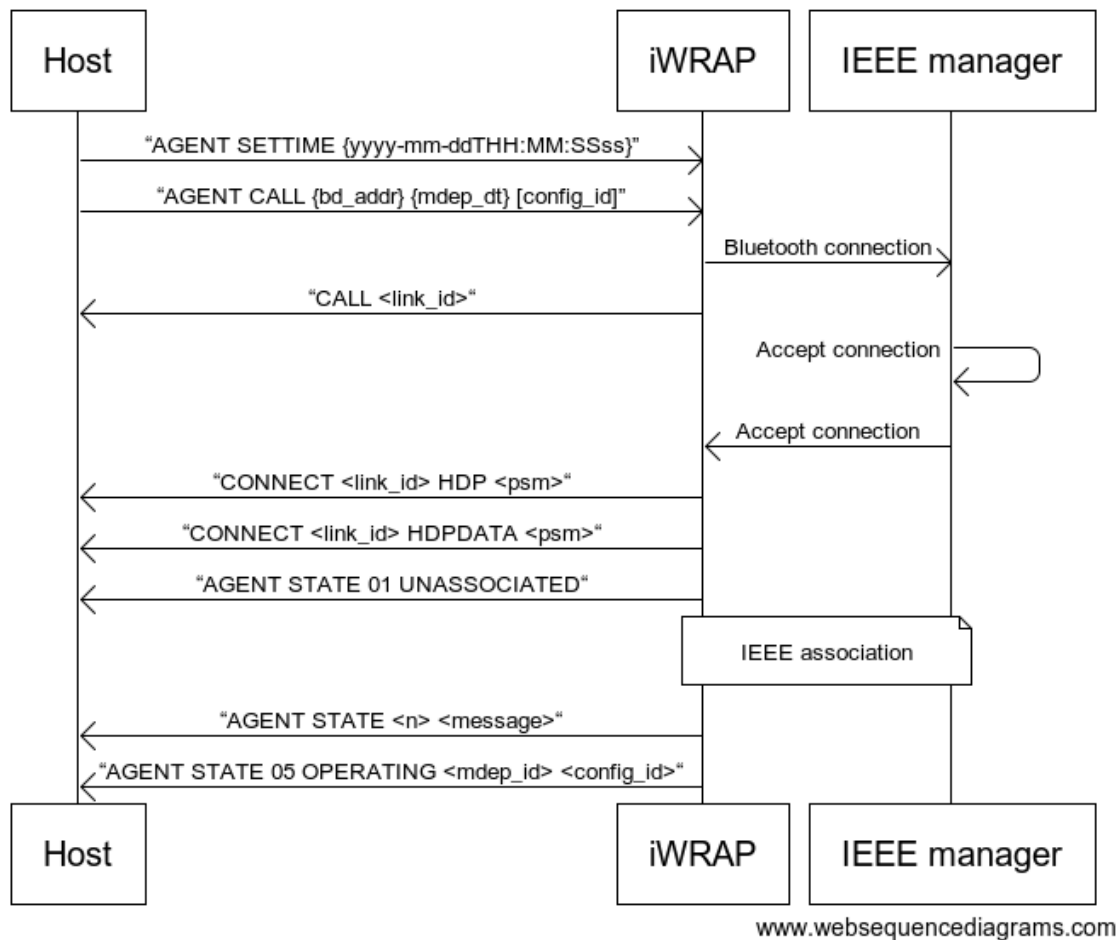
Figure 5: Connection establishment sequence

1. Bluetooth connection establishment begins when the host sends **AGENT SETTIME** and **AGENT CALL** commands

2. When connection establishment starts, iWRAP produces **CALL <link_id>** event indicating and outgoing connection attempt

3. If the Bluetooth connection is successful an **CONNECT** event is produced. With HDP profile two event are produced indicating both HDP control and HDP data channels.

    a. In case the connection establishment fails an **NO CARRIER** event is produced and an error code and reason are printed out.

4. Next iWRAP starts the IEEE association procedure and indicates this **AGENT STATE 01 UNASSOCIATED** event

5. During the IEEE association several **AGENT STATE** events are produced indicating the progress of the association and possible failures.

6. A successful IEEE association is indicated by **AGENT STATE 05 OPERATING** events. The event contains the *mdep_id* and also the *config_id* of the IEEE configuration the manager accepted.

8.5 Manual IEEE association

iWRAP will automatically make the IEEE association when an outgoing connection is made. However in some cases a manual association needs to be made, for example when the connection is received from the IEEE manager. The command to do the association is:

"AGENT ASSOCIATE {*mdep_dt***} [***config_id***]"**

>>> ***mdep_dt***   MDEP data type.

>>> ***config_id***   Preferred IEEE configuration ID. **(Optional)**

Below is an example how to set up a HDP connection from iWRAP to AP3201 using the Blood Pressure Monitor service.

```
RING 0 00:07:80:ff:fa:12 1001 HDP            (MCL connection reception)
HDP 0 MDL req 0001 -> 1 CONFIG 1             (MDL negotiation)
RING 1 00:07:80:ff:fa:12 1003 HDPDATA        (MDL connection reception)
AGENT STATE 01 UNASSOCIATED                  (Agent state event)
AGENT ASSOCIATE 1007                         (Agent association request)
AGENT STATE 03 ASSOCIATING
AGENT STATE 07 SENDING_CONFIG                (IEEE configuration negotiation)
AGENT STATE 06 WAITING_APPROVAL
AGENT STATE 05 OPERATING 1007 02bc           (Successful IEEE association)
```

Once the event **AGENT STATE 05 OPERATING 1007 02bc** is received the agent is ready to send the data reports to the manager. If this state is not reaced the association with the manager has failed.

1007 tells the MDEP data type (Blood Pressure Monitor in this case).

02bc tells the IEEE configuration the manager has approved.

8.6 Changing IEEE configuration

It is possible to change the IEEE configuration during a connection. Two steps are needed to change the configuration:

1. First agent is disassociated with command: "**AGENT DISACCOSIATE CONFIG**"
2. Then the "**AGENT ASSOCIATE**" command is used to associate with new configuration

Below is an example how to change the configuration.

AGENT STATE 05 OPERATING 1007 02bc	(Agent is in operating state)
AGENT DISASSOCIATE CONFIG	(IEEE disassociation)
AGENT STATE 02 DISASSOCIATING	
AGENT STATE 01 UNASSOCIATED	
AGENT ASSOCIATE 100F	(IEEE association with new configuration)
AGENT STATE 03 ASSOCIATING	
AGENT STATE 07 SENDING_CONFIG	(IEEE configuration negotiation)
AGENT STATE 06 WAITING_APPROVAL	
AGENT STATE 05 OPERATING 100f 4002	(Successful IEEE association)

The "**CONFIG**" parameter for the disassociate command indicates that the reason for disassociation is the intention to change the configuration. This intention is also reported to the manager. If the parameter is omitted, the manager may disconnect the Bluetooth link after disassociation.

8.7 Data transmission

The actual data transmission is made in several steps:

1. First the attributes that are updated and their values are indicated to the iWRAP firmware

2. Then a command is given to iWRAP telling that the information can transmitted to the *Bluetooth* link

3. Finally a confirmation event is displayed that the manager has received and acknowledged the measurement.

The command to update the objects, attributes and their values is:

"AGENT UPDATE {*person_id*} {*object_id*} {*attribute_id*} [*value*]"

person_id	IEEE person ID. In single user devices the default ***FFFF*** value should be used.
	In multi-user device every used must have a unique person ID.
obj_id	IEEE object ID which is updated.
attr_id	IEEE attribute ID which is updated*.*
value	Value for the attribute.

When the **AGENT UPDATE** command is given without any parameters iWRAP sends the measurement over *Bluetooth* to the IEEE manager.

The following examples show how the transactions are made.

The example below shows how a blood pressure measurement is constructed and transmitted.

```
AGENT UPDATE ffff 1 a75 120e0,80e0,100e0      (systolic, diastolic and mean pressure values)
AGENT UPDATE ffff 1 990 2010-11-03T21:19:0000 (Time-stamp of above measurement)
AGENT UPDATE ffff 2 a4c 60e0                  (Heart rate value)
AGENT UPDATE ffff 2 990 2010-11-03T21:19:0200 (Time-stamp for Heart rate value)
AGENT UPDATE                                  (Transmission of measurement)
AGENT EVENT CONFIRMED                         (Confirmation from IEEE manager)
```


The example below shows how a weight scale measurement is made and transmitted.

```
AGENT UPDATE ffff 1 a4c 90.0                  (Weight value)
AGENT UPDATE ffff 1 990 2010-11-03T21:20:0000 (Time-stamp of weight measurement)
AGENT UPDATE                                  (Transmission of measurement)
AGENT EVENT CONFIRMED                         (Confirmation from IEEE manager)
```


The example below shows how a blood glucose meter measurement is made and transmitted.

```
AGENT UPDATE ffff 1 a4c 85e0                  (Blood glucose value)
AGENT UPDATE ffff 1 990 2010-11-03T21:22:0100 (Time-stamp of blood glucose measurement)
AGENT UPDATE                                  (Transmission of measurement)
AGENT EVENT CONFIRMED                         (Confirmation from IEEE manager)
```

8.7.1 Updatable attributes

The list of attributes, which may be updated:

Attribute name	Attribute ID (hexadecimal)	Attribute type
Basic-Nu-Observed-Value	a4c	SFLOAT
Compound-Basic-Nu-Observed-Value	a75	Comma-separated list of Basic-Nu-Observed-Values
Nu-Observed-Value	a56	FLOAT
Absolute-Time-Stamp	990	AbsoluteTime
Unit-Code	996	INT-U16
Enum-Observed-Value-Simple-OID	a49	INT-U16
Enum-Observed-Value-Simple-Bit-Str	a65	INT-U32
Measure-Active-Period	a59	FLOAT
Metric-Id	92b	INT-U16
Metric-Id-List	a76	Comma-separated list of Metric-Ids

Parsing rules for attributes:

Attribute type	Parsing rules	Special values	Example
SFLOAT	{mantissa}[e{exponent}] *mantissa: [-2045, 2045]* *exponent: [-8, 7]*	**NAN** = not a number **NRES** = not at this resolution **+INFinity** **-INFinity**	32 = 32 32e-1 = 3.2 -32e1 = -320
FLOAT	{mantissa}[e{exponent}] *mantissa: [-8388605, 8388605]* *exponent: [-128, 127]*	*See above*	*See above*
AbsoluteTime	**yyyy-mm-ddTHH:MM:SSss**		2011-02-09T12:00:0000
INT-U16	**16-bit hexadecimal number**		
INT-U32	**32-bit hexadecimal number**		

8.8 Connection termination

The connection termination is made in three steps:

3. First agent is disassociated with command: "**AGENT DISACCOSIATE**"
4. Then MDL link is terminated with command: "**HDP DELETE {*mdl_link_id*}**"
5. Finally the MCL link is terminated with command: "**CLOSE {*link_id*}**"

This example shows the IEEE disassociation and HDP connection termination.

AGENT DISASSOCIATE	(IEEE disassociation)
AGENT STATE 02 DISASSOCIATING	
AGENT STATE 01 UNASSOCIATED	
HDP DELETE 1	(MDL deletion)
AGENT STATE 00 DISCONNECTED	
NO CARRIER 1 ERROR 0	
HDP 0 DELETE 0001	
CLOSE 0	(MCL termination)
NO CARRIER 0 ERROR 0	
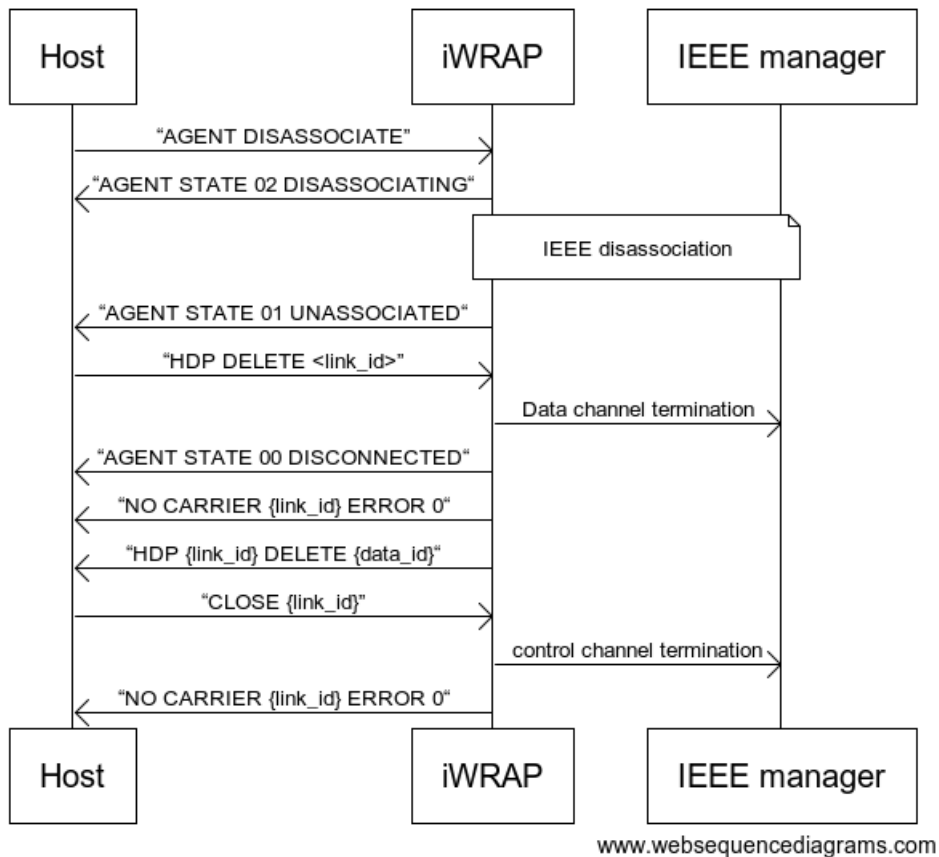
Figure 6: Connection termination sequence

1. Bluetooth cconnection termination by first doing the IEEE disassociation with **AGENT DISASSOCIATE** command.

2. iWRAP indicates the IEEE disassociation process with two **AGENT STATE** events. The **AGENT STATE 01 UNASSOCIATED** indicates a successful disassociation.

3. To terminate the HDP data channel a **HDP DELETE {link_id}** command is used. The *link_id* refers to the link ID of the data channel.

4. Next iWRAP indicates the IEEE disconnection with **AGENT STATE** event and the Bluetooth connection termination with **NO CARRIER** event.

5. Also a HDP control channel event is displayed indicating the termination of the data channel. The event is **HDP {*link_id*} DELETE {*data_id*}**. The *link_id* refers to the HDP control channel ID and *data_id* refers to the HDP data channel ID.

6. Finally the HDP control channel is terminated with **CLOSE {*link_id*}** command.

7. iWRAP indicates the connection termination with **NO CARRIER** event.

8.9 IEEE configuration

The IEEE specification allows devices to use either a so called standard configuration or alternatively an extended configuration where a device provides more data in the measurement reports. As an example a weight scale provides only a weight measurement and an associated time-stamp in the standard configuration, but in the extended configuration it could also provide body mass index (BMI).

Developers can make their own extended configurations and use them with the iWRAP IEEE agent mode. Bluegiga provides an extended configuration toolkit that allows rapid and simple development of extended agent configurations. The toolkit allows the extended agent configurations with a simple eXtensible Markup Language (XML) based language.

The toolkit also contains software tools to compile and install extended agent configuration into the iWRAP firmware, allowing developers to quickly create and deploy new agent devices.

Please contact Bluegiga Technologies for more information about the extended agent configuration toolkit.

8.9.1 IEEE configurations

The following standard and extended configurations are supported by iWRAP 5.0.0.

8.9.1.1 Blood Pressure Monitor

Configuration type: **Standard configuration**

Configuration ID: **02bc**

obj_id	attr_id	value	type	Unit	Description	Mandatory
Blood pressure object						
1	a75	*{systolic},{diastolic},{mean}*	sfloat,sfloat,sfloat	mmHg	blood pressure values	Yes
1	990	*{yyyy-mm-ddTHH:MM:SSss}*	timestamp	-	Time of BP measurement	Yes
Pulse rate object						
2	a4c	*{pulse_rate}*	sfloat	bpm	Pulse rate	Yes
2	990	*yyyy-mm-ddTHH:MM:SSss*	timestamp	-	Time of pulse rate measurement	No

8.9.1.2 Blood Glucose Meter

Configuration type: **Standard configuration**

Configuration ID: **06a4**

obj_id	attr_id	value	type	Unit	Description	Mandatory
Blood glucose level object						
1	a4c	*{glucose}*	sfloat	mg/DL	blood glucose consentration	Yes

Configuration type: **Extended configuration**

Configuration ID: **4001**

obj_id	attr_id	value	type	Unit	Description	Mandatory
Blood glucose level object						
1	a4c	*{glucose}*	sfloat	depends on unit_code	blood glucose consentration	Yes
1	990	*{yyyy-mm-ddTHH:MM:SSss}*	timestamp	-	Time stamp	Yes
1	996	*{unit_code}*	Must be one of: 0852 = mg/DL (default) 1272 = mmol/L	mg/DL or mmol/L	Unit code of measurement	No
HbA1c1 object						
2	a4c	*{HbA1c1}*	sfloat	per cent	glycatged homoglobin	Yes
2	990	*{yyyy-mm-ddTHH:MM:SSss}*	timestamp	-	Time stamp	Yes
Exercise context object						
3	a4c	*{ntensity}*	sfloat	per cent	intensity of exercise	Yes
3	a59	*{duration}*	float	seconds	duration of exercise	Yes
3	990	*{yyyy-mm-ddTHH:MM:SSss}*	timestamp	-	Time stamp	Yes
Medication context object						
4	92b	*{physio}*	Must be one of: 7208=MEDICATION_RAPIDACTING 720c=MEDICATION_SHORTACTING 7210=MEDICATION_INTERMEDIATEACTING	-	Medciation type	Yes

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			7214=MEDICATION_LONGACTING 7218=MEDICATION_PREMIX			
4	a4c	*{amount}*	sfloat	depends on unit_code	amount of medicationt	Yes
4	990	*{yyyy-mm-ddTHH:MM:SSss}*	timestamp	-	Time stamp	Yes
4	996	*{unit_code}*	Must be one of: 06d2 = mg (default) 0652 = ml	mg or ml	Unit code of medication	No
Carbohydrates object						
5	92b	*{physio}*	Must be one of: 71e8= GLU_CARB_BREAKFAST 71ec= GLU_CARB_LUNCH 71f0= GLU_CARB_DINNER 71f4= GLU_CARB_SNACK 71f8= GLU_CARB_DRINK 71fc= GLU_CARB_SUPPER 7200= GLU_CARB_BRUNCH	-	Carbohydrates type	Yes
5	a4c	*{amount}*	sfloat	g	amount of carbohydrates	Yes
5	990	*{yyyy-mm-ddTHH:MM:SSss}*	timestamp	-	Time stamp	Yes
Device annunciation status object						
6	a65	*{status}*	bitmask. See below: device-battery-low - 0x8000 sensor-malfunction - 0x4000 sensor-sample-size-insufficient - 0x2000 sensor-strip-insertion - 0x1000 sensor-strip-type-incorrect - 0x0800 sensor-result-too-high - 0x0400 sensor-result-too-low - 0x0200 sensor-temp-too-high - 0x0100 sensor-temp-too-low - 0x0080 sensor-read-interrupt - 0x0040 device-gen-fault - 0x0020		Device status flags	Yes
6	990	*{yyyy-mm-ddTHH:MM:SSss}*	timestamp	-	Time stamp	Yes

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Meal context object							
7	a49	*{meal}*	Must be one of: 724c= GLU_MEAL_PREPRANDIAL 7250=GLU_MEAL_POSTPRANDIAL 7254=GLU_MEAL_FASTING 7258= GLU_MEAL_CASUAL	-		Meal type	Yes
7	990	*{yyyy-mm-ddTHH:MM:SSss}*	timestamp	-		Time stamp	Yes
Sample location object							
8	a49	*{location}*	Must be one of: 7238 =SAMPLELOCATION_FINGER 7244= SAMPLELOCATION_CTRLSOLUTION	-		Sample location	Yes
8	990	*{yyyy-mm-ddTHH:MM:SSss}*	timestamp	-		Time stamp	Yes
Tester context object							
9	a49	*{tester}*	Must be one of: 7260=MDC_CTXT_GLU_TESTER_SELF 7264=MDC_CTXT_GLU_TESTER_HCP 7268=MDC_CTXT_GLU_TESTER_LAB	-		Who did the measurement	Yes
9	990	*{yyyy-mm-ddTHH:MM:SSss}*	timestamp	-		Time stamp	Yes
Health context object							
10	a49	*{health}*	Must be one of: 7220=MDC_CTXT_GLU_HEALTH_MINOR 7224=MDC_CTXT_GLU_HEALTH_MAJOR 7228=MDC_CTXT_GLU_HEALTH_MENSES 722c=MDC_CTXT_GLU_HEALTH_STRESS 7230=MDC_CTXT_GLU_HEALTH_NONE	-		Patient health state	Yes
10	990	*{yyyy-mm-ddTHH:MM:SSss}*	timestamp	-		Time stamp	Yes

8.9.1.3 Weight scale

Configuration type: **Standard configuration**

Configuration ID: **05dc**

obj_id	attr_id	value	type	Unit	Description	Mandatory
Body mass object						
1	a4c	*{body_mass}*	sfloat	kg	body mass	Yes
1	990	*{yyyy-mm-ddTHH:MM:SSss}*	timestamp	-	Time stamp	No

Configuration type: **Extended configuration**

Configuration ID: **4002**

obj_id	attr_id	value	type	Unit	Description	Mandatory
Body mass object						
1	a4c	*{body_mass}*	sfloat	depends on unit_code	body mass	Yes
1	990	*{yyyy-mm-ddTHH:MM:SSss}*	timestamp	-	Time stamp	No
1	996	*{unit_code}*	Must be one of: 06c3= MDC_DIM_KILO_G (default) 06e0= MDC_DIM_LB	kg or lb	Unit code of body mass	No
Body height object						
2	a4c	*{height}*	sfloat	depends on unit_code	body height value	Yes
2	990	*{yyyy-mm-ddTHH:MM:SSss}*	timestamp	-	Time stamp	No
2	996	*{unit_code}*	Must be one of: 0511= MDC_DIM_CENTI_M (default) 0560 = MDC_DIM_INCH	cm or inch	Unit code of body height	No
Body fat object						
3	a4c	*{fat}*	sfloat	depends on unit_code	body fat value	Yes
3	990	*{yyyy-mm-ddTHH:MM:SSss}*	timestamp	-	Time stamp	No
3	996	*{unit_code}*	Must be one of: 0220 =	percent,	Unit code of body fat	No

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| | | | | MDC_DIM_PERCENT (default) 06c3 = MDC_DIM_KILO_G 06e0 = MDC_DIM_LB | kg or lb | | |

Body mass without fat object							
4	a4c	*{mass_without_fat}*	sfloat	depends on unit_code	body mass without fat		Yes
4	990	*{yyyy-mm-ddTHH:MM:SSss}*	timestamp	-	Time stamp		No
4	996	*{unit_code}*	Must be one of: 06c3 = MDC_DIM_KILO_G (default) 06e0 = MDC_DIM_LB	kg or lb	Unit code of body mass without fat		No
Soft lean mass object							
5	a4c	*{soft_lean_mass}*	sfloat	depends on unit_code	body soft lean mass		Yes
5	990	*{yyyy-mm-ddTHH:MM:SSss}*	timestamp	-	Time stamp		No
5	996	*{unit_code}*	Must be one of: 06c3 = MDC_DIM_KILO_G (default) 06e0 = MDC_DIM_LB	kg or lb	Unit code of body soft lean mass		No
Body water amount object							
6	a4c	*{body_water_amount}*	sfloat	depends on unit_code	body water amount		Yes
6	990	*{yyyy-mm-ddTHH:MM:SSss}*	timestamp	-	Time stamp		No
6	996	*{unit_code}*	Must be one of: 0220 = MDC_DIM_PERCENT (default) 06c3 = MDC_DIM_KILO_G 06e0 = MDC_DIM_LB	kg or lb	Unit code of body water amount		No
Body mass index object							
7	a4c	*{body_mass_index}*	sfloat	kg / m^2	Body mass index		Yes
7	990	*{yyyy-mm-ddTHH:MM:SSss}*	timestamp	-	Time stamp		No

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8.9.1.4 Body Thermometer

Configuration type: **Standard configuration**

Configuration ID: **0320**

obj_id	attr_id	value	type	Unit	Description	Mandatory
Body mass object						
1	a4c	*{body_temperature}*	sfloat	kg	body temperature	Yes
1	990	*{yyyy-mm-ddTHH:MM:SSss}*	timestamp	-	Time stamp	No

8.9.1.5 Pulse Oximeter

Configuration type: **Standard configuration**

Configuration ID: **0190**

obj_id	attr_id	value	type	Unit	Description	Mandatory
Oxygen saturation object						
1	a4c	*{oxygen_saturation}*	sfloat	Per cent	Oxygen saturation	Yes
1	990	*{yyyy-mm-ddTHH:MM:SSss}*	timestamp	-	Time stamp	No
Pulse rate object						
a	a4c	*{pulse_rate}*	sfloat	bpm	Pulse rate	Yes
a	990	*{yyyy-mm-ddTHH:MM:SSss}*	timestamp	-	Time stamp	No

8.9.1.6 Body Composition Analyzer

Configuration type: **Standard configuration**

Configuration ID: **07d0**

obj_id	attr_id	value	type	Unit	Description	Mandatory
Manually entered body mass object						
1	a4c	*{body_mass}*	sfloat	kg	Body mass	Yes
1	990	*{yyyy-mm-ddTHH:MM:SSss}*	timestamp	-	Time stamp	No
Body height object						
2	a4c	*{body_height}*	sfloat	cm	Body height	Yes

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2	990	*{yyyy-mm-ddTHH:MM:SSss}*	timestamp	-	Time stamp	No
Body fat object						
3	a4c	*{body_fat}*	sfloat	%	Body fat	Yes
3	990	*{yyyy-mm-ddTHH:MM:SSss}*	timestamp	-	Time stamp	No

Configuration type: **Extended configuration**

Configuration ID: **4002**

obj_id	*attr_id*	*value*	*type*	Unit	Description	Mandatory
Body mass object						
1	a4c	*{body_mass}*	sfloat	depends on unit_code	body mass	Yes
1	990	*{yyyy-mm-ddTHH:MM:SSss}*	timestamp	-	Time stamp	No
1	996	*{unit_code}*	Must be one of: 06c3= MDC_DIM_KILO_G (default) 06e0= MDC_DIM_LB	kg or lb	Unit code of body mass	No
Body height object						
2	a4c	*{height}*	sfloat	depends on unit_code	body height value	Yes
2	990	*{yyyy-mm-ddTHH:MM:SSss}*	timestamp	-	Time stamp	No
2	996	*{unit_code}*	Must be one of: 0511= MDC_DIM_CENTI_M (default) 0560 = MDC_DIM_INCH	cm or inch	Unit code of body height	No
Body fat object						
3	a4c	*{fat}*	sfloat	depends on unit_code	body fat value	Yes
3	990	*{yyyy-mm-ddTHH:MM:SSss}*	timestamp	-	Time stamp	No
3	996	*{unit_code}*	Must be one of: 0220 = MDC_DIM_PERCENT (default) 06c3 = MDC_DIM_KILO_G 06e0 = MDC_DIM_LB	percent, kg or lb	Unit code of body fat	No

Body mass without fat object							
4	a4c	*{mass_without_fat}*	sfloat	depends on unit_code	body mass without fat	Yes
4	990	*{yyyy-mm-ddTHH:MM:SSss}*	timestamp	-	Time stamp	No
4	996	*{unit_code}*	Must be one of: 06c3 = MDC_DIM_KILO_G (default) 06e0 = MDC_DIM_LB	kg or lb	Unit code of body mass without fat	No
Soft lean mass object							
5	a4c	*{soft_lean_mass}*	sfloat	depends on unit_code	body soft lean mass	Yes
5	990	*{yyyy-mm-ddTHH:MM:SSss}*	timestamp	-	Time stamp	No
5	996	*{unit_code}*	Must be one of: 06c3 = MDC_DIM_KILO_G (default) 06e0 = MDC_DIM_LB	kg or lb	Unit code of body soft lean mass	No
Body water amount object							
6	a4c	*{body_water_amount}*	sfloat	depends on unit_code	body water amount	Yes
6	990	*{yyyy-mm-ddTHH:MM:SSss}*	timestamp	-	Time stamp	No
6	996	*{unit_code}*	Must be one of: 0220 = MDC_DIM_PERCENT (default) 06c3 = MDC_DIM_KILO_G 06e0 = MDC_DIM_LB	kg or lb	Unit code of body water amount	No
Body mass index object							
7	a4c	*{body_mass_index}*	sfloat	kg / m^2	Body mass index	Yes
7	990	*{yyyy-mm-ddTHH:MM:SSss}*	timestamp	-	Time stamp	No

8.10 IEEE agent mode

This chapter contains full examples how to use iWRAP in both HDP gateway and IEEE agent modes.

8.10.1   Standard configuration Blood pressure monitor

SET PROFILE HDP AGENT 2 BPM Bluegiga 0001	(Enables IEEE agent mode)
SET BT SSP 3 0	(Enables SSP "Just works" mode)
SET BT AUTH * 0000	(Set's *Bluetooth* pin code to 0000)
SET BT CLASS 000904	(Sets class-of-device for a BPM)
RESET	(Reset is needed to active settings)
AGENT SETTIME 2010-11-03T20:10:0000	(Agent time configuration)
AGENT CALL 00:07:80:89:56:f6 1007	(Connection establishment)
CALL 0	(Connection establishement is started)
CONNECT 0 HDP feff	(Successful MCL creation)
HDP 0 MDL 0001 CONFIG 1	
CONNECT 1 HDPDATA fefd	(Successful MDL creation)
AGENT STATE 01 UNASSOCIATED	(Start of IEEE association)
AGENT STATE 03 ASSOCIATING	
AGENT STATE 07 SENDING_CONFIG	(IEEE configuration negotiation)
AGENT STATE 06 WAITING_APPROVAL	
AGENT STATE 05 OPERATING 1007 02bc	(Successful IEEE association)
	(Standard configuration with ID **02bc** used)
AGENT UPDATE ffff 1 a75 160e0,50e0,80e0	(systolic: 160, diastolic: 50, mean: 80)
AGENT UPDATE ffff 1 990 2010-11-10T12:34:5678	(Time stamp for BP measurement)
AGENT UPDATE ffff 2 a4c 110e0	(Pulse Rate: 110)
AGENT UPDATE ffff 2 990 2010-11-10T12:35:5678	(Time stamp for BPM measurement)
AGENT UPDATE	(Measurement transmission)
AGENT EVENT CONFIRMED	(Confirmation from IEEE manager)
AGENT DISASSOCIATE	(IEEE disassociation)
AGENT STATE 02 DISASSOCIATING	
AGENT STATE 01 UNASSOCIATED	
HDP DELETE 1	(MDL deletion)
AGENT STATE 00 DISCONNECTED	
NO CARRIER 1 ERROR 0	
HDP 0 DELETE 0001	
CLOSE 0	(MCL termination)
NO CARRIER 0 ERROR 0	

8.10.2   Standard configuration Blood glucose meter

```
SET PROFILE HDP AGENT 20 BGM Bluegiga 0002      (Enables IEEE agent mode)
SET BT SSP 3 0                                   (Enables SSP "Just works" mode)
SET BT AUTH * 0000                               (Set's Bluetooth pin code to 0000)
SET BT CLASS 000910                              (Sets class-of-device for a BGM)
RESET                                            (Reset is needed to active settings)


AGENT SETTIME 2010-11-03T20:10:0000             (Agent time configuration)


AGENT CALL 00:07:80:89:56:f6 1011               (Connection establishment)
CALL 0                                           (Connection establishement is started)
CONNECT 0 HDP feff                               (Successful MCL creation)
HDP 0 MDL 0001 CONFIG 1
CONNECT 1 HDPDATA fefd                           (Successful MDL creation)
AGENT STATE 01 UNASSOCIATED                      (Start of IEEE association)
AGENT STATE 03 ASSOCIATING
AGENT STATE 07 SENDING_CONFIG                    (IEEE configuration negotiation)
AGENT STATE 06 WAITING_APPROVAL
AGENT STATE 05 OPERATING 1011 4001              (Successful IEEE association)
                                                 (Extended configuration with ID 4001 used)


AGENT UPDATE ffff 1 a4c 160e-1                   (Blood glucose concentration: 16.0 mg/DL)
AGENT UPDATE                                      (Measurement transmission)
AGENT EVENT CONFIRMED                            (Confirmation from IEEE manager)


AGENT DISASSOCIATE                               (IEEE disassociation)
AGENT STATE 02 DISASSOCIATING
AGENT STATE 01 UNASSOCIATED
HDP DELETE 1                                      (MDL deletion)
AGENT STATE 00 DISCONNECTED
NO CARRIER 1 ERROR 0
HDP 0 DELETE 0001
CLOSE 0                                          (MCL termination)
NO CARRIER 0 ERROR 0
```

8.10.3　Standard configuration Weight Scale

```
SET PROFILE HDP AGENT 8 WS Bluegiga 0003        (Enables IEEE agent mode)
SET BT SSP 3 0                                   (Enables SSP "Just works" mode)
SET BT AUTH * 0000                               (Set's Bluetooth pin code to 0000)
SET BT CLASS 00090C                              (Sets class-of-device for a WS)
RESET                                            (Reset is needed to active settings)


AGENT SETTIME 2010-11-03T20:10:0000             (Agent time configuration)


AGENT CALL 00:07:80:99:92:8a 100F 05dc          (Connection establishment)
CALL 0                                          (Connection establishement is started)
CONNECT 0 HDP feff                              (Successful MCL creation)
HDP 0 MDL 0001 CONFIG 1
CONNECT 1 HDPDATA fefd                          (Successful MDL creation)
AGENT STATE 01 UNASSOCIATED                     (Start of IEEE association)
AGENT STATE 03 ASSOCIATING
AGENT STATE 07 SENDING_CONFIG                   (IEEE configuration negotiation)
AGENT STATE 06 WAITING_APPROVAL
AGENT STATE 05 OPERATING 100F 05dc              (Successful IEEE association)
                                                (Standard configuration with ID 05dc used)


AGENT UPDATE ffff 1 a4c 1601e-1                 (Body weight: 160.1kg)
AGENT UPDATE ffff 1 990 2010-11-10T12:34:5678   (Time stamp of body weight)
AGENT UPDATE                                     (Measurement transmission)
AGENT EVENT CONFIRMED                           (Confirmation from IEEE manager)


AGENT DISASSOCIATE                              (IEEE disassociation)
AGENT STATE 02 DISASSOCIATING
AGENT STATE 01 UNASSOCIATED
HDP DELETE 1                                     (MDL deletion)
AGENT STATE 00 DISCONNECTED
NO CARRIER 1 ERROR 0
HDP 0 DELETE 0001
CLOSE 0                                          (MCL termination)
NO CARRIER 0 ERROR 0
```

8.10.4   Standard configuration Pulse Oximeter

```
SET PROFILE HDP AGENT 1 POS Bluegiga 0001        (Enables IEEE agent mode)
SET BT SSP 3 0                                    (Enables SSP "Just works" mode)
SET BT AUTH * 0000                                (Set's Bluetooth pin code to 0000)
SET BT CLASS 000914                               (Sets class-of-device for a POS)
RESET                                             (Reset is needed to active settings)


AGENT SETTIME 2010-11-03T20:10:0000              (Agent time configuration)


AGENT CALL 00:07:80:99:92:8a 1004                (Connection establishment)
CALL 0                                            (Connection establishement is started)
CONNECT 0 HDP feff                                (Successful MCL creation)
HDP 0 MDL 0001 CONFIG 1
CONNECT 1 HDPDATA fefd                            (Successful MDL creation)
AGENT STATE 01 UNASSOCIATED                       (Start of IEEE association)
AGENT STATE 03 ASSOCIATING
AGENT STATE 07 SENDING_CONFIG                     (IEEE configuration negotiation)
AGENT STATE 06 WAITING_APPROVAL
AGENT STATE 05 OPERATING 1004 0190               (Successful IEEE association)
                                                  (Standard configuration with ID 0190 used)
AGENT UPDATE ffff 1 a4c 99e0                      (Oxygen saturation is 99%)
AGENT UPDATE ffff 1 990 2010-11-10T12:34:5678     (Time stamp of oxygen saturation measurement)
AGENT UPDATE ffff a a4c 90e0                      (Pulse rate is 90bpm)
AGENT UPDATE ffff a 990 2010-11-10T12:34:5678     (Time stamp of pulse rate measurement)
AGENT UPDATE                                      (Measurement transmission)
AGENT EVENT CONFIRMED                             (Confirmation from IEEE manager)


AGENT DISASSOCIATE                                (IEEE disassociation)
AGENT STATE 02 DISASSOCIATING
AGENT STATE 01 UNASSOCIATED
HDP DELETE 1                                       (MDL deletion)
AGENT STATE 00 DISCONNECTED
NO CARRIER 1 ERROR 0
HDP 0 DELETE 0001
CLOSE 0                                            (MCL termination)
NO CARRIER 0 ERROR 0
```

8.10.5   Standard configuration Body Thermometer

```
SET PROFILE HDP AGENT 4 BTM Bluegiga 0001      (Enables IEEE agent mode)
SET BT SSP 3 0                                 (Enables SSP "Just works" mode)
SET BT AUTH * 0000                             (Set's Bluetooth pin code to 0000)
SET BT CLASS 000908                            (Sets class-of-device for a HTM)
RESET                                          (Reset is needed to active settings)


AGENT SETTIME 2011-05-10T16:10:0000            (Agent time configuration)


AGENT CALL 00:07:80:99:92:8a 1008             (Connection establishment)
CALL 0                                         (Connection establishement is started)
CONNECT 0 HDP feff                             (Successful MCL creation)
HDP 0 MDL 0001 CONFIG 1
CONNECT 1 HDPDATA fefd                         (Successful MDL creation)
AGENT STATE 01 UNASSOCIATED                    (Start of IEEE association)
AGENT STATE 03 ASSOCIATING
AGENT STATE 07 SENDING_CONFIG                  (IEEE configuration negotiation)
AGENT STATE 06 WAITING_APPROVAL
AGENT STATE 05 OPERATING 1008 0320             (Successful IEEE association)
                                               (Standard configuration with ID 0320 used)
AGENT UPDATE ffff 1 a4c 361e-1                 (Temperature 36.1 C)
AGENT UPDATE ffff 1 990 2011-05-10T16:15:0000  (Time stamp of temperature measurement)
AGENT UPDATE                                   (Measurement transmission)
AGENT EVENT CONFIRMED                          (Confirmation from IEEE manager)


AGENT DISASSOCIATE                             (IEEE disassociation)
AGENT STATE 02 DISASSOCIATING
AGENT STATE 01 UNASSOCIATED
HDP DELETE 1                                   (MDL deletion)
AGENT STATE 00 DISCONNECTED
NO CARRIER 1 ERROR 0
HDP 0 DELETE 0001
CLOSE 0                                        (MCL termination)
NO CARRIER 0 ERROR 0
```

8.10.6   Standard configuration Body Composition Analyzer

```
SET PROFILE HDP AGENT 100 BCA Bluegiga Agent 0001        (Enables IEEE agent mode)
SET BT SSP 3 0                                           (Enables SSP "Just works" mode)
SET BT AUTH * 0000                                       (Set's Bluetooth pin code to 0000)
SET BT CLASS 000924                                      (Sets class-of-device for a BCA)
RESET                                                    (Reset is needed to active settings)


AGENT SETTIME 2011-05-10T16:10:0000        (Agent time configuration)


AGENT CALL 00:07:80:99:92:8a 1014 07D0     (Connection establishment)
CALL 0                                     (Connection establishment is started)
CONNECT 0 HDP feff                         (Successful MCL creation)
HDP 0 MDL 0001 CONFIG 1
CONNECT 1 HDPDATA fefd                     (Successful MDL creation)
AGENT STATE 01 UNASSOCIATED                (Start of IEEE association)
AGENT STATE 03 ASSOCIATING
AGENT STATE 07 SENDING_CONFIG              (IEEE configuration negotiation)
AGENT STATE 06 WAITING_APPROVAL
AGENT STATE 05 OPERATING 1014 07d0         (Successful IEEE association)
                                           (Standard configuration with ID 07d0 used)
AGENT UPDATE FFFF 1 a4c 873e-1             (Body mass 87.3 kg)
AGENT UPDATE FFFF 1 990 2011-05-10T16:15:0000   (Time stamp of body mass setting)
AGENT UPDATE FFFF 2 a4c 1875e-1            (Body height 187.5 cm)
AGENT UPDATE FFFF 2 990 2011-05-10T16:15:0000   (Time stamp of body height setting)
AGENT UPDATE FFFF 3 a4c 192e-1            (Body fat percentage 19.2 %)
AGENT UPDATE FFFF 3 990 2011-05-10T16:15:0000   (Time stamp of body fat calculation)
AGENT UPDATE                               (Measurement transmission)
AGENT EVENT CONFIRMED                      (Confirmation from IEEE manager)
AGENT DISASSOCIATE                         (IEEE disassociation)
AGENT STATE 02 DISASSOCIATING
AGENT STATE 01 UNASSOCIATED
HDP DELETE 1                               (MDL deletion)
AGENT STATE 00 DISCONNECTED
NO CARRIER 1 ERROR 0
HDP 0 DELETE 0001
CLOSE 0                                    (MCL termination)
NO CARRIER 0 ERROR 0
```

9 *Bluetooth* and Continua compliance and certification

iWRAP5 is Bluetooth qualified with QDID : B019486

iWRAP5 is designed and tested to meet the requirements of Continua v.1.5.

10 Terminology

This section describes the terminologies used to describe the profile.

Initiator / Acceptor

The device that initiates the Control Channel connection becomes the "Initiator" of the connection. The device addressed in a Control Channel connection request is the "Acceptor" of the connection.

Control Channel / Data Channel

The first L2CAP channel established between two implementations of MCAP is the "Control Channel". This channel facilitates the creation of "Data Channels," through which actual health device data, which the Optimized Exchange Protocol and Device Specializations define, is exchanged.

Streaming and Reliable Data Channels

Two fundamental types of Data Channels exist in HDP: Reliable Data Channels and Streaming Data Channels. Reliable Data Channels are appropriate for transmitting measurement or alert information where the confidence in the exchange is at its highest (e.g. store and forward measurement). Streaming Data Channels are useful when the timeliness of the delivery of each frame is more important than the reliable delivery of every frame (e.g. an ECG waveform, where the low latency is critical). Support for Reliable Data Channels is mandatory for all *Sources* and *Sinks*, while support for Streaming Data Channels is mandatory for all *Sinks* in order to support *Sources* that may request it.

MCAP Data End Point (MDEP)

An MCAP Data End Point (MDEP) represents one logical function, i.e. one "feature", of a device. Each MDEP is described by a set of parameters and includes the following: MDEP ID, MDEP Role (*Source*/*Sink*), MDEP Data Type (Device Specialization), and MDEP Description. Note that a device may have multiple features - for example, it could measure both blood pressure and heart rate, in which case it could host two different MDEPs.

MCAP Data Link (MDL)

An MCAP Data Link (MDL) identifies a pair of MDEPs, one each for *Source* and *Sink*, and its explicit creation occurs by one of the two participating devices as result of a request on the Control Channel.

MCAP Communications Link (MCL)

An MCAP Communications Link (MCL) refers to the collection of L2CAP connections between two instances of MCAP and comprises of a Control Channel and zero or more Data Channels.

MCAP Instance

An MCAP instance can have one or more MCLs. If there are two MCAP instances, then there will be two HDP instances with separate SDP records and at least two instances of the IEEE data layer.

Source: [1]

11 More information

This application note only focuses of the *Bluetooth* Health Device Profile and how it is used with iWRAP firmware. Only partial descriptions of iWRAP commands are shown and only a minority of available iWRAP commands is discussed. Please refer to *iWRAP4 User Guide* for full description of iWRAP commands, responses and events. iWRAP user guide is available via the Bluegiga's Tech Forum.

The iWRAP firmware discussed in this application note is available for the following *Bluetooth* modules:

- WT12, class 2 *Bluetooth* module

- WT11, class 1 *Bluetooth* module

- WT41, class 1, long range *Bluetooth* module

- WT11i, class 1 Bluetooth module

For more information about these products, please go to www.bluegiga.com or contact us via email.

For more information about IEEE standards, please refer to IEEE 11073-20601 Optimized Exchange Protocol and 11073-104xx Device Data Specializations. They are available for example via the IEEE web store.

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12 References

[1]   The *Bluetooth* SIG, HEALTH DEVICE PROFILE Implementation Guidance Whitepaper, April 2009

[2]   The *Bluetooth* SIG, *Bluetooth* Host Operating environment Assigned numbers

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