

***Bluetooth*® A2DP AND AVRCP PROFILES**

iWRAP APPLICATION NOTE

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Version 1.3

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VERSION HISTORY

Version	Comment
1.0	First version
1.1	Added chapter 3.5.4
1.2	Updated to reflect the changes in iWRAP5, corrected errors in chapter 3.1, detailed chapter 3.5.3
1.3	iWRAP5 release updates

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1 Introduction

This application note discusses *Bluetooth* Advanced Audio Distribution Profile (A2DP) and *Bluetooth* Audio/video Remote Control Profile (AVRCP) their advantages and how these profiles can be used. Also practical examples are given how the A2DP and AVRCP profiles are used with the iWRAP firmware.

1.1 Advanced Audio Distribution Profile

A2DP describes how stereo-quality audio can be streamed from a media source to a sink. The audio source is the music player and the audio sink is the wireless headset or wireless stereo speakers.

The profile defines two roles of an audio device: source and sink.

- **A2DP Source** – A device is the source when it acts as a source of a digital audio stream that is delivered to the SINK of the piconet.
- **A2DP Sink** – A device is the sink when it acts as a sink of a digital audio stream delivered from the SOURCE on the same piconet.

A2DP defines the protocols and procedures that realize distribution of audio content of high-quality in mono or stereo on ACL channels. The term “advanced audio,” therefore, should be distinguished from “*Bluetooth* audio,” which indicates distribution of narrow band voice on SCO channels as defined in the baseband specification.

A2DP profile includes mandatory support for low complexity sub-band codec (SBC) and supports optionally MPEG-1,2 Audio, MPEG-2,4 AAC, ATRAC or other codecs.

The audio data is compressed in a proper format for efficient use of the limited bandwidth. Surround sound distribution is not included in the scope of this profile.



Figure 1: Typical A2DP use case

Source: [1]

1.2 Audio/video Remote Control Profile

AVRCP is designed to provide a standard interface to control TVs, Hi-Fi equipment, or others to allow a single remote control (or other device) to control all the A/V equipment to which a user has access. It may be used in concert with A2DP or VDP.

Basically your action manipulates the control. You can adjust menu functions that are already commonly used, such as adjusting the brightness of your TV or hue, or a VCR timer, as well as audio functions like sound adjustments, play, pause, skip, etc.

The AVRCP defines two roles, that of a controller and target device.

- **Controller** – The controller is typically considered the remote control device.
- **Target** – The target device is the one whose characteristics are being altered.

In a “walkman” type media player scenario, the control device may be a headset that allows tracks to be skipped and the target device would be the actual medial player.

In AVRCP, the controller translates the detected user action to the A/V control signal, and then transmits it to a remote *Bluetooth* enabled device. The functions available for a conventional infrared remote controller can be realized in this protocol. The remote control described in this protocol is designed specifically for A/V control only.



Figure 2: Typical AVRCP use case

Source: [2]

2 iWRAP firmware overview

iWRAP is an embedded firmware running entirely on the RISC processor of WT12, WT11i, WT41 and WT32 modules. It implements the full *Bluetooth* protocol stack and many *Bluetooth* profiles. All software layers, including application software, run on the internal RISC processor in a protected user software execution environment known as a Virtual Machine (VM).

The host system can interface to iWRAP firmware through one or more physical interfaces, which are also shown in the figure below. The most common interfacing is done through the UART interface by using the ASCII commands that iWRAP firmware supports. With these ASCII commands, the host can access *Bluetooth* functionality without paying any attention to the complexity, which lies in the *Bluetooth* protocol stack. GPIO interface can be used for event monitoring and command execution. PCM, SPDIF, I2S or analog interfaces are available for audio. The available interfaces depend on the used hardware.

The user can write application code to the host processor to control iWRAP firmware using ASCII commands or GPIO events. In this way, it is easy to develop *Bluetooth* enabled applications.

On WT32 there is an extra DSP processor available for data/audio processing.

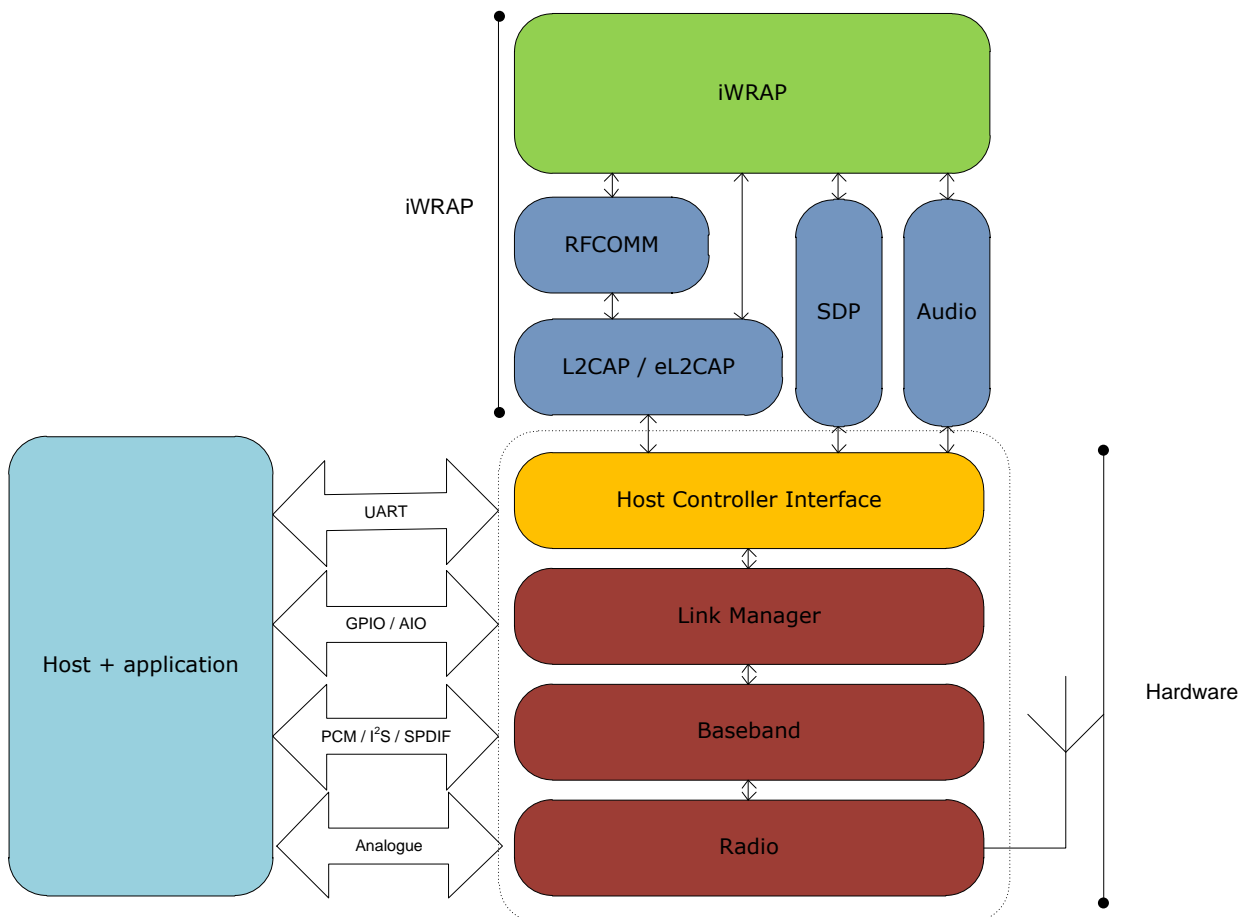


Figure 3: iWRAP Stack

In the figure above, a *Bluetooth* module with iWRAP firmware could be connected to a host system for example through the UART interface. The options are:

- If the host system has a processor, software can be used to control iWRAP by using ASCII based commands or GPIO events.
- If there is no need to control iWRAP, or the host system does not need a processor, iWRAP can be configured to be totally transparent and autonomous, in which case it only accepts connections or automatically opens them.
- GPIO lines that *Bluetooth* modules offer can also be used together with iWRAP to achieve additional functionality, such as Carrier Detect or DTR signaling.
- Audio interfaces can be used to transmit audio over a *Bluetooth* link.

3 Using A2DP and AVRCP with iWRAP

This chapter instructs the A2DP and AVRCP usage and configuration with the iWRAP firmware.

3.1 Configuration

3.1.1 A2DP Sink and AVRCP Controller

Perhaps the most common use case for A2DP and AVRCP is the wireless headset with remote control capabilities. The A2DP Sink enables audio streaming from an audio source, whereas AVRCP Controller facilitates over-the-air control of the audio stream.

A2DP Sink is enabled with iWRAP command:

“SET PROFILE A2DP SINK”.

AVRCP controller on the other hand is enabled with command:

“SET PROFILE AVRCP CONTROLLER”

The mobile phones, tablets and PC to recognize the device as a wireless headset the *Bluetooth* Class of Device (CoD) must be configured to reflect the device’s capabilities. Some devices may not be able to discover and connect the A2DP unless the CoD is properly set.

The A2DP specification mandates that for the A2DP Sink, the Rendering Service bit (0x040000) is set. It is also recommended to set the Audio Service bit (0x200000) and set the Major Device Class to Audio/Video (0x000400).

The Minor Device Class should be set according to what type of device is in question, for example Headphones (0x000018) and Hi-Fi Audio Device (0x000028). The combined CoD is 0x240438.

Class of device is configured with iWRAP command:

“SET BT CLASS {cod}”

Finally a reset is needed to for the A2DP profile to become active.

Below is an example how to configure iWRAP as A2DP sink and AVRCP controller and with proper CoD.

```
SET PROFILE A2DP SINK
SET PROFILE AVRCP CONTROLLER
SET BT CLASS 240438
RESET
```

3.1.2 A2DP Source and AVRCP Target

Another very common scenario is an audio source which can be remote controlled, such as a home stereo system.

Much like in the previous example, “**SET PROFILE A2DP SOURCE**” and “**SET PROFILE AVRCP TARGET**” must be issued to enable the profiles.

As in the previous example, the Class of Device must be set properly. In the case of A2DP Source, the specification mandates the use of the Capturing Service bit (0x080000). The Audio Service (0x200000) and Audio/Video Major Device Class (0x000400) should be used, but they are not mandatory.

A common example Minor Device Class is Hi-Fi Audio Device (0x000028). The combined CoD is then 0x280428.

Finally a reset is needed for the A2DP profile to become active.

```
SET PROFILE A2DP SOURCE  
SET PROFILE AVRCP TARGET  
SET BT CLASS 280428  
RESET
```

3.1.3 Security configuration

To be able to pair with other *Bluetooth* enabled devices the *Bluetooth* security needs to be properly configured. iWRAP support Secure Simple Pairing (SSP) defined in *Bluetooth 2.1 + EDR* specification, and the use of it is mandatory, but PIN code pairing is also supported to enable pairing with legacy devices.

In order to enable SSP and PIN code pairing, the following configuration commands are needed:

“SET BT SSP 3 0” This enables SSP “just works” mode, where no PIN code entry or passkey verification is needed. To enable the optional man-in-the-middle protection, please refer to iWRAP user guide.

“SET BT AUTH * <pin>” This command enables PIN code pairing, to support pairing with legacy defines. **<pin>** is the desired PIN code, which can be 1-16 alphanumeric characters.

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

Below is an example how to enable SSP just works and PIN code pairing in iWRAP.

```
SET BT SSP 3 0
SET BT AUTH * 0000
RESET
```

3.2 Service discovery

Bluetooth technology enables 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 iWRAP the service discovery is performed with command: "**SDP {bd_addr} {uuid}**".

bd_addr	<i>Bluetooth</i> device address of the remote device.
uuid	Universally unique identifier. Refers to the <i>Bluetooth</i> profile one wants to discover. For A2DP sink the uuid is 110B, for A2DP source 110A for AVRCP target 110C and for AVRCP controller 110E.

Below is an example how to perform a service discovery to an A2DP sink.

SDP 00:07:80:81:66:6f 110B

```
SDP 00:07:80:81:66:6f < I SERVICENAME S "Stereo Headset" > < I PROTOCOLDESCRIPTORLIST < < U L2CAP I 19 > < U 0019 I 100 > > >
```

SDP

Stereo Headset	= Service name
19	= L2CAP psm for A2DP sink

Below is an example how to perform a service discovery to a A2DP source.

SDP 00:07:80:93:0c:aa 110A

```
SDP 00:07:80:93:0c:aa < I SERVICENAME S "Stereo Audio" > < I PROTOCOLDESCRIPTORLIST < < U L2CAP I 19 > < U 0019 I 100 > > >
```

SDP

Below is an example how to perform a service discovery to a AVRCP controller.

SDP 00:07:80:93:0c:aa 110C

```
SDP 00:07:80:81:66:6f < I SERVICENAME S "A/V Controller" > < I PROTOCOLDESCRIPTORLIST < < U L2CAP I 17 > < U 0017 I 104 > > >
```

SDP

A/V Controller	= Service name
17	= L2CAP psm for A2DP source

Below is an example how to perform a service discovery to a AVRCP target..

SDP 00:07:80:93:0c:aa 110E

```
SDP 00:07:80:93:0c:aa < I SERVICENAME S "A/V Target" > < I PROTOCOLDESCRIPTORLIST < < U L2CAP I 17 > < U 0017 I 103 > > >
```

SDP

3.3 Connection establishment

3.3.1 A2DP connection

A2DP profile requires two connections, one for a control channel and second for a data channel. However iWRAP automatically sets up both the connections so the user does not need to worry about setting up two channels.

The A2DP connection is opened, typical to iWRAP, with a **CALL** command:

“CALL {*bd_addr*} 19 A2DP”

bd_addr *Bluetooth* device address of the remote device.

Below is an example how to set up an A2DP connection.

```
CALL 00:07:80:81:66:6f 19 A2DP
```

```
CALL 0
```

```
CONNECT 0 A2DP 19
```

```
CONNECT 1 A2DP 19
```

```
A2DP STREAMING START 0
```

A typical indications of outgoing call and successful connection are received (**CALL** and **CONNECT**). Two connection events are typically received indicating the establishment of control and data channels.

Also typically a third event is received indicating that A2DP streaming is started:

“A2DP STREAMING START {*link_id*}”

link_id Numeric connection identifier which started streaming.

Note:

iWRAP allows you to set up several simultaneous A2DP connections. However, only one of the connections can be streaming audio at a time.

3.3.2 AVRCP connection

The AVRCP connection is opened, typical to iWRAP, with a **CALL** command:

“CALL {*bd_addr*} 17 A2DP”

bd_addr *Bluetooth* device address of the remote device.

Below is an example how to set up an AVRCP connection.

```
CALL 00:07:80:81:66:6f 17 AVRCP
```

```
CALL 2
```

```
CONNECT 2 AVRCP 17
```

Typical indications for outgoing call and successful connection are received (**CALL** and **CONNECT**) and in the case of when the connection establishment is not successful **CALL** and **NO CARRIER** events are received.

3.4 Connection termination

3.4.1 A2DP connection

The A2DP connection is simply closed with iWRAP command “**CLOSE {link_id}**”. One should always terminate the first A2DP connection (control channel) and not second connection (data channel). Terminating the control channel makes iWRAP also terminate the data channel.

Below is an example of A2DP connection termination.

```
CLOSE 0  
A2DP STREAMING STOP 0  
NO CARRIER 0 ERROR 0  
NO CARRIER 1 ERROR 0
```

Typically first an indication of A2DP streaming stop is received:

“**A2DP STREAMING STOP {link_id}**”

link_id

Numeric connection identifier of link which started streaming.

Then normal **NO CARRIER** events are received for both A2DP connections.

3.4.2 AVRCP connection

The A2DP connection is simply closed with iWRAP command “**CLOSE {link_id}**”.

Below is an example of AVRCP connection termination.

```
CLOSE 2  
NO CARRIER 2 ERROR 0
```

Then normal **NO CARRIER** event is received.

3.5 General A2DP and AVRCP information

This chapter contains general information and tips about the iWRAP and A2DP profile for the implementers.

3.5.1 A2DP commands

The table below lists the possible A2DP commands. See iWRAP user guide for exact details.

Command	Function
A2DP STREAMING START	Starts A2DP streaming
A2DP ATREAMING STOP	Stops A2DP streaming

Table 1: Supported A2DP commands

3.5.2 AVRCP commands

The table below lists the possible AVRCP commands.

Command	Description
AVRCP UP	Volume up
AVRCP DN	Volume down
AVRCP MUTE	Mute
AVRCP STOP	Stop
AVRCP PLAY	Play
AVRCP PAUSE	Pause
AVRCP REWIND	Rewind
AVRCP FAST_FORWARD	Fast Forward
AVRCP FORWARD	Forward (next song)
AVRCP BACKWARD	Backward (previous song)
AVRCP {raw}	AVRCP command in raw hex mode. Available codes: 00-13, 20-2c, 30-37, 40-4B, 50-51, 71-75 and 7e
AVRCP PDU {PDU_ID} [parameters]	PDU_ID AVRCP PDU ID parameters AVRCP PDU parameters Please refer to the following page for available PDU_IDs and parameters .

Table 2: Available AVRCP commands

Note: See iWRAP user guide for more details and examples of how to use the AVRCP commands.

3.5.3 AVRCP PDU

3.5.3.1 Syntax

AVRCP PDU command is used by the AVRCP Controller to send metadata request Protocol Data Units to the Target.

Synopsis

AVRCP PDU {*PDU_ID*} [*parameters*]

PDU ID	Description and parameters
10	Get capabilities command. Query for events or Company_ID's the Target supports. Parameters: 2 Query supported Company_ID's. 3 Query supported events.
11	List player application settings. No parameters.
12	List possible values for a player application setting. Parameters: { <i>setting_id</i> } See list at the end of this command's description.
13	Get current values of player application settings. Parameters: { <i>number of settings</i> } Number of following parameters. Followed by: { <i>setting_id</i> } See list at the end of this command's description.
14	Set current values of player application settings. Parameters: { <i>number of settings</i> } Number of <i>setting_id</i> -value-pairs that follow. Followed by:

	<p>{setting_id} {value}</p> <p>See list at the end of this command's description.</p>
20	<p>Get attributes of the currently playing track.</p> <p>Parameters:</p> <p>{number of attributes}</p> <p>Number of attributes that follow. If zero, list all available information.</p> <p>Followed by (unless number of attributes is zero):</p> <p>[attribute_id]</p> <p>See list at the end of this command's description.</p>
30	<p>Get the playing status, length and position of the current track. No parameters.</p>
31	<p>Register notification of events. This will request the Target to notify us when a track is changed for instance.</p> <p>Parameters:</p> <p>{event_id}</p> <p>See list at the end of this command's description.</p>
50	<p>Set the absolute volume on the target device.</p> <p>Parameters:</p> <p>{volume}</p> <p>The requested volume level. The valid range is 0x00-0x7f.</p>

Note: The AVRCP profile specification contains the details of the possible PDU ID and a detailed description of the parameters.

Note: Not all the AVRCP commands are supported by the AVRCP target devices and most of them actually implement only a small subset of all the available commands.

3.5.3.2 Events

AVRCP PDU command may return the following events

Events
<p>AVRCP {PDU_ID name}_RSP [parsed data]</p> <p>AVRCP RSP PDU_ID {PDU_ID}, data: [unparsed data]</p> <p>AVRCP {PDU_ID name}_RSP REJ</p>

List of supported **attribute_ids**, **event_ids**, **setting_ids**, and their respective **values**.

Type	ID	Explanation
Attribute	0x01	Song title
Attribute	0x02	Artist
Attribute	0x03	Album title
Attribute	0x04	Track number in numeric ASCII text
Attribute	0x05	Total number of tracks on album in numeric ASCII text
Attribute	0x06	Genre
Attribute	0x07	Playing time in milliseconds in numeric ASCII text
Setting	0x01	Equalizer setting, values: 0x01 Off 0x02 On
Setting	0x02	Repeat setting, values: 0x01 Off 0x02 Single track 0x03 All tracks 0x04 Group
Setting	0x03	Shuffle setting, values: 0x01 Off 0x02 All tracks 0x03 Group
Setting	0x04	Scan setting, values: 0x01 Off 0x02 All tracks 0x03 Group
Event	0x01	Playback status changed
Event	0x02	Track changed
Event	0x03	Track reached end
Event	0x04	Track reached start

Event	0x05	Playback position changed
Event	0x06	Battery status changed
Event	0x07	System status changed
Event	0x08	Player application setting changed
Event	0x09	Now playing changed
Event	0x0a	Available players changed
Event	0x0b	Addressed players changed
Event	0x0c	UIDs changed
Event	0x0d	Volume changed

3.5.3.3 Examples

Query supported AVRCP events.

AVRCP PDU 10 3

AVRCP GET_CAPABILITIES_RSP EVENT COUNT 3 PLAYBACK_STATUS_CHANGED TRACK_CHANGED PLAYBACK_POSITION_CHANGED

Ask the Target about its player application settings, their possible values and change a value.

AVRCP PDU 11

AVRCP LIST_APPLICATION_SETTING_ATTRIBUTES_RSP COUNT 2 REPEAT SHUFFLE

AVRCP PDU 12 2

AVRCP LIST_APPLICATION_SETTING_VALUES_RSP COUNT 3 1 2 3

AVRCP PDU 13 1 2

AVRCP GET_APPLICATION_SETTING_VALUE_RSP COUNT 1 REPEAT OFF

AVRCP PDU 14 1 2 2

AVRCP SET_APPLICATION_SETTING_VALUE_RSP

AVRCP PDU 13 1 2

AVRCP GET_APPLICATION_SETTING_VALUE_RSP COUNT 1 REPEAT SINGLE_TRACK

Ask the Target about the title and artist of the song that is currently playing and ask it to notify us if the playback status changes.

AVRCP PDU 20 2 1 2

AVRCP GET_ELEMENT_ATTRIBUTES_RSP COUNT 2 TITLE "Cold Women and Warm Beer" ARTIST "The Black League"

AVRCP PDU 31 1 1

AVRCP REGISTER_NOTIFICATION_RSP INTERIM PLAYBACK_STATUS_CHANGED PLAYING
(the interim response is received right after the request to confirm we were registered for notification)

AVRCP REGISTER_NOTIFICATION_RSP CHANGED PLAYBACK_STATUS_CHANGED PAUSED
(the changed response is received when the playing status changes)

3.5.4 iWRAP commands related to audio

- PLAY** - Command **PLAY** is used to generate tones or beeps.
- VOLUME** - Changes the volume level (audio output gain).
- SET CONTROL AUDIO** - This command controls the physical interface routing of audio on WT32. The command is also used to enable or disable multiple SCO support.
- SET CONTROL CODEC** - This command controls the preference of A2DP audio codecs, channel modes and sampling rates for A2DP.
- SET CONTROL GAIN** - **SET CONTROL GAIN** is used to control the internal input and output gain.
- SET CONTROL MICBIAS** - **SET CONTROL MICBIAS** controls the linear regulator that drives current through the dedicated mic bias pin.
- SET CONTROL PCM** - This command configures the physical PCM hardware interface settings and PCM data format.
- SET CONTROL RINGTONE** - Configures a ring tone which is used with HFP or HSP profile if the Audio Gateway does not provide an in-band ring tone.
- SET CONTROL PREAMP** - Enables or disables the 20dB microphone pre-amplifier.

Please refer to iWRAP user guide for exact documentation of the listed commands.

NOTE:

The pre-amplifier **MUST** be turned off in A2DP source device to prevent the low frequencies being cut out.

4 Power saving

iWRAP offers two power saving options. Sniff mode, which can be used to save power for active *Bluetooth* connections and deep sleep mode which puts the internal processor into a reduced duty cycle mode. Please refer to iWRAP user guide for more information about sniff and deep sleep modes. One should be very careful when using sniff mode with an active A2DP connection. Sniff mode will reduce the data transmission rate and therefore affect the robustness of an audio link. When sniff mode is used with A2DP audio “clipping” is more likely to occur than without power saving.

One should also know that when *Bluetooth* connections are in active mode i.e. no power saving in use the master device uses 3-4 times less power than a slave device. Therefore for battery powered applications it might be useful to configure the device as a master rather than a slave.

5 Audio quality improvement

The sub-band coding (SBC) used to encode or decode the A2DP audio is a lossy audio codec and some of the audio data is lost when it's transmitted over a *Bluetooth* link. For some applications like high end headsets and headphones or audio amplifiers this may not be acceptable.

Alternative audio codecs can be used to encode or decode the audio stream and provide better quality or lower latency *Bluetooth* audio. Such codes are for example MP3, AAC or aptX. MP3 codec is however not generally supported by *Bluetooth* enabled cell phones, tablets and PCs. ACC is codec is supported in the latest generation Apple devices. aptX codec on the other hand has received the widest market adoption and is supported by many cell phones, tablets, PCs and headsets.

aptX codec provides a nearly lossless audio quality and therefore is ideal to be used in Hi-Fi audio applications and products where high quality *Bluetooth* audio is needed. iWRAP supports aptX codec, but because it's a 3rd party codec and has an extra license fee it's not included in the generic firmware builds. For more information about aptX codec, please contact sales@bluegiga.com.

6 References

- [1] The *Bluetooth* SIG, A2DP Profile overview, URL:
<http://Bluetooth.com/Bluetooth/Technology/Works/A2DP.htm>

- [2] The *Bluetooth* SIG, AVRCP Profile overview, URL:
<http://Bluetooth.com/Bluetooth/Technology/Works/AVRCP.htm>

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