

# Voice Assistant Profile – Hearing Access Profile

## Bluetooth® Change Request

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- **Prepared By:** Hearing Aid Working Group

This Change Request proposes changes to the following specification:

- Hearing Access Profile Version 1.0.1 (“Source Specification”)

This document proposes changes to the Hearing Access Profile to include support for the Voice Assistant Profile (VAP) Terminal and VAP Gateway roles as defined in VAP [15].

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### Abstract:

This profile defines the requirements for Bluetooth devices necessary for interoperability within the hearing aid ecosystem. It specifies behaviors related to audio streaming and remote control of the hearing aid using the Bluetooth Low Energy Audio (LE Audio) framework.

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# 1 Introduction

The purpose of the Hearing Access Profile (HAP) is to define the requirements for an interoperable experience for users of hearing aids and complementary products in the hearing aid ecosystem that use Bluetooth Low Energy (LE) Audio technology with the Isochronous Channels feature.

To accomplish this, the HAP mandates requirements for products within the hearing aid ecosystem.

Wherever a reference to a hearing aid is made, that term covers:

- A single hearing aid, rendering a single audio channel
- A pair of hearing aids (also called a Binaural Hearing Aid Set) supporting individual left and right audio channels
- A hearing aid that uses a single Bluetooth link but provides separate left and right audio outputs to the user

A single hearing aid always contains one or more external microphones to detect external sound. This specification does not distinguish between one or more external microphones within a hearing aid. All external microphones that are present are collectively described as a single entity within the single hearing aid. In a Binaural Hearing Aid Set, an implementation can decide to expose the availability of a microphone from one hearing aid or both hearing aids to send the user’s voice to the peer device (e.g., smartphone, laptop, etc.) during a call. How the two hearing aids agree on which microphone to expose to the peer device in this scenario is not defined by this specification.

## 1.1 Language

### 1.1.1 Language conventions

In the development of a specification, the Bluetooth SIG has established the following conventions for use of the terms “shall”, “mandatory”, “shall not”, “should”, “should not”, “may”, “optional”, “must”, and “can”. In this Bluetooth specification, the terms in Table 1.1 have the specific meanings given in that table, irrespective of other meanings that exist.

| Term                     | Definition                                                                                                                  |
|--------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| shall<br>or<br>mandatory | <u>—used to express what is required by the specification and is to be implemented exactly as written without deviation</u> |
| shall not                | <u>—used to express what is forbidden by the specification</u>                                                              |

| Term                                                                     | Definition                                                                                                                                                                                                                                |
|--------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>should</u><br><u>or</u><br><u>may</u><br><u>or</u><br><u>optional</u> | <u>—not mandatory. Used to express either:</u><br><u>1. what is recommended by the specification without forbidding anything (“should”)</u><br><u>2. what is permissible within the limits of the specification (“may” or “optional”)</u> |
| <u>should not</u>                                                        | <u>—used to indicate that something is discouraged but not forbidden by the specification</u>                                                                                                                                             |
| <u>must</u>                                                              | <u>—used to indicate either:</u><br><u>1. an indisputable statement of fact that is always true regardless of the circumstances</u><br><u>2. an implication or natural consequence if a separately-stated requirement is followed</u>     |
| <u>can</u>                                                               | <u>—used to express a statement of possibility or capability</u>                                                                                                                                                                          |

*Table 1.1: Language conventions terms and definitions*

Where more than one item is permitted but not required, the choices to include or support those items are independent from one another unless the specification explicitly states otherwise. Each item that is implemented shall be implemented exactly as written without deviation.

#### **1.1.1.1 Implementation alternatives**

When specification content indicates that there are multiple alternatives to satisfy specification requirements, if one alternative is explained or illustrated in an example it is not intended to limit other alternatives that the specification requirements permit.

#### **1.1.1.2 Discrepancies**

It is the goal of Bluetooth SIG that specifications are clear, unambiguous, and do not contain discrepancies. However, members can report any perceived discrepancy by filing an erratum and can request a test case waiver as appropriate.

#### **1.1.2 Reserved for Future Use**

Where a field in a packet, Protocol Data Unit (PDU), or other data structure is described as "Reserved for Future Use" (irrespective of whether in uppercase or lowercase), the device creating the structure shall set its value to zero unless otherwise specified. Any device receiving or interpreting the structure shall ignore that field; in particular, it shall not reject the structure because of the value of the field.

Where a field, parameter, or other variable object can take a range of values, and some values are described as "Reserved for Future Use," a device sending the object shall not set the object to those

values. A device receiving an object with such a value should reject it, and any data structure containing it, as being erroneous; however, this does not apply in a context where the object is described as being ignored or it is specified to ignore unrecognized values.

When a field value is a bit field, unassigned bits can be marked as Reserved for Future Use and shall be set to 0. Implementations that receive a message that contains a Reserved for Future Use bit that is set to 1 shall process the message as if that bit was set to 0, except where specified otherwise.

The acronym RFU is equivalent to Reserved for Future Use.

### 1.1.3 Prohibited

When a field value is an enumeration, unassigned values can be marked as “Prohibited.” These values shall never be used by an implementation, and any message received that includes a Prohibited value shall be ignored and shall not be processed and shall not be responded to.

Where a field, parameter, or other variable object can take a range of values, and some values are described as “Prohibited,” devices shall not set the object to any of those Prohibited values. A device receiving an object with such a value should reject it, and any data structure containing it, as being erroneous.

“Prohibited” is never abbreviated.

## 1.2 Requirements in Tables

Requirements in this specification are defined as "Mandatory" (M), "Optional" (O), "Excluded" (E), “Not Applicable” (N/A), or "Conditional" (C.#). Conditional statements (C.#) are listed directly below the table in which they appear.

- “M” for mandatory. See Table 1.1: Language conventions terms and definitions.
- “O” for optional. See Table 1.1: Language conventions terms and definitions.
- “E” for excluded. “Excluded” means not permitted in this context; cannot be supported or included for this purpose. The item can still be supported or included if allowed for some other purpose (e.g., a feature can be mandatory for one role and excluded for another; a device that supports both roles must support this feature).
- “C.#” for conditional. “Conditional” means that an item is required, optional, or prohibited based on whether one or more other items are supported or included (# represents any number). Within the definition of the condition, if those other items mean that “not permitted” applies, it has the same meaning as “E”.

### 1.2.1 Table requirements for unused cells

An unused cell is a table cell without a value or content, which is indicated with either the word “none” (without quotation marks) or a hyphen (i.e., a “minus” sign).

To use an additional form of notation in this specification’s tables—such as an ellipsis (...) to indicate a gap in a series of values—add an explanation of that notation in the specification’s section on table conventions for requirements and unused cells. If a particular table uses a notation that differs from the initially expressed table conventions for unused cells, explain this additional notation in the introduction of the table to which it applies.

## 1.3 Conformance

Each capability of this specification shall be supported in the specified manner. This specification may provide options for design flexibility, because, for example, some products do not implement every portion of the specification. For each implementation option that is supported, it shall be supported as specified.

## 1.4 Profile dependencies

This profile ~~requires the~~ includes requirements from Common Audio Profile (CAP) [4], Basic Audio Profile (BAP) [3], Volume Control Profile (VCP) [11], Microphone Control Profile (MICP) [12], Coordinated Set Identification Profile (CSIP) [6], Call Control Profile (CCP) [13], ~~and the~~ Generic Attribute Profile (GATT) [1], and the Voice Assistant Profile (VAP) [15].

## ~~1.1~~ Conformance

~~Each capability of this specification shall be supported in the specified manner. This specification may provide options for design flexibility, because, for example, some products do not implement every portion of the specification. For each implementation option that is supported, it shall be supported as specified.~~

Bluetooth Core Specification release compatibility

### ~~1.21.5~~ Bluetooth Core Specification release compatibility

~~This profile requires Bluetooth Core Specification 5.2 [1] or later for the Hearing Aid (HA), Hearing Aid Unicast Client (HAUC) and Hearing Aid Remote Controller (HARC) roles (see Sections 3, 4, and 5). If the Immediate Alert Client (IAC) role (see Section 6) is the only HAP role implemented on a device, this profile requires Bluetooth Core Specification 4.2 [9] or later.~~ This profile requires Bluetooth Core Specification 5.2 [1] or later for the Hearing Aid (HA), Hearing Aid Unicast Client (HAUC) and Hearing Aid Remote Controller (HARC) roles (see Sections 3, 4, and 5). If the Immediate Alert Client (IAC) role (see Section 6) is the only HAP role implemented on a device, this profile requires Bluetooth Core Specification 4.2 [9] or later.

## ~~1.31.6~~ Change History

This section summarizes changes at a moderate level of detail and should not be considered representative of every change made.

### 1.3.11.6.1 Changes from v1.0 to v1.0.1

| Section                                | Errata |
|----------------------------------------|--------|
| 1.2: Conformance                       | E23815 |
| 2.2: Role/profile relationships        | E19220 |
| 3.6: CSIP Set Member role requirements | E23132 |

Table 1.2: Errata incorporated in v1.0.1

## 1.6.2 Changes from v1.0.1 to v1.1

### 1.6.2.1 New and updated features

| Feature Name                    | Description                                                                   | Location                                  |
|---------------------------------|-------------------------------------------------------------------------------|-------------------------------------------|
| Voice Assistant Profile support | Added requirements for devices that support the Voice Assistant Profile (VAP) | 1.1, 2.2, 3.7, 4.3, 9, 10, Appendices A-C |

Table 1.2: New and updated features

## 1.4—Language

### 1.4.1—Language conventions

The Bluetooth SIG has established the following conventions for use of the words ***shall***, ***must***, ***will***, ***should***, ***may***, ***can***, and ***note*** in the development of specifications:

|        |                                                                                                                                                                                                                                              |
|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| shall  | <del>is required to</del> —used to define requirements.                                                                                                                                                                                      |
| must   | <del>is used to express:</del><br><del>a natural consequence of a previously stated mandatory requirement.</del><br><del>OR</del><br><del>an indisputable statement of fact (one that is always true regardless of the circumstances).</del> |
| will   | <del>it is true that</del> —only used in statements of fact.                                                                                                                                                                                 |
| should | <del>is recommended that</del> —used to indicate that among several possibilities one is recommended as particularly suitable, but not required.                                                                                             |
| may    | <del>is permitted to</del> —used to allow options.                                                                                                                                                                                           |

|      |                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| can  | <del>is able to—used to relate statements in a causal manner.</del>                                                                                                                                                                                                                                                                                                                                                                          |
| note | <del>Text that calls attention to a particular point, requirement, or implication or reminds the reader of a previously mentioned point. It is useful for clarifying text to which the reader ought to pay special attention. It shall not include requirements. A note begins with “Note:” and is set off in a separate paragraph. When interpreting the text, the relevant requirement shall take precedence over the clarification.</del> |

If there is a discrepancy between the information in a figure and the information in other text of the specification, the text prevails. Figures are visual aids including diagrams, message sequence charts (MSCs), tables, examples, sample data, and images. When specification content shows one of many alternatives to satisfy specification requirements, the alternative shown is not intended to limit implementation options. Other acceptable alternatives to satisfy specification requirements may also be possible.

### 1.4.2—Reserved for Future Use

Where a field in a packet, Protocol Data Unit (PDU), or other data structure is described as "Reserved for Future Use" (irrespective of whether in uppercase or lowercase), the device creating the structure shall set its value to zero unless otherwise specified. Any device receiving or interpreting the structure shall ignore that field; in particular, it shall not reject the structure because of the value of the field.

Where a field, parameter, or other variable object can take a range of values, and some values are described as "Reserved for Future Use," a device sending the object shall not set the object to those values. A device receiving an object with such a value should reject it, and any data structure containing it, as being erroneous; however, this does not apply in a context where the object is described as being ignored or it is specified to ignore unrecognized values.

When a field value is a bit field, unassigned bits can be marked as Reserved for Future Use and shall be set to 0. Implementations that receive a message that contains a Reserved for Future Use bit that is set to 1 shall process the message as if that bit was set to 0, except where specified otherwise.

The acronym RFU is equivalent to Reserved for Future Use.

### 1.4.3—Prohibited

When a field value is an enumeration, unassigned values can be marked as “Prohibited.” These values shall never be used by an implementation, and any message received that includes a Prohibited value shall be ignored and shall not be processed and shall not be responded to.

Where a field, parameter, or other variable object can take a range of values, and some values are described as “Prohibited,” devices shall not set the object to any of those Prohibited values. A device receiving an object with such a value should reject it, and any data structure containing it, as being erroneous.

“Prohibited” is never abbreviated.

## 1.51.7 General interpretation rules

The interpretation rules defined in Section 1.5 of [3] apply throughout this specification.

## 1.61.8 Terminology

Table 1.3 defines terms that are needed to understand features used in this specification.

| Term                     | Definition                                  |
|--------------------------|---------------------------------------------|
| Active preset            | Defined in Hearing Access Service (see [5]) |
| Active preset record     | Defined in [5]                              |
| Banded Hearing Aid       | Defined in [5]                              |
| Binaural Hearing Aid Set | Defined in [5]                              |
| Monaural Hearing Aid     | Defined in [5]                              |
| Preset record            | Defined in [5]                              |

Table 1.3: Terminology

## 2 Configuration

HAP specifies configurations and settings of parameters and procedures that are defined in lower-level specifications.

HAP specifies the following:

- HAP profile roles
- Procedures used with the Hearing Access Service (HAS)
- Requirements imposed on the other LE Audio profiles supported by HAP for interoperability purposes

### 2.1 Roles

HAP defines the following profile roles:

- **Hearing Aid (HA).** The HA role is implemented in a hearing aid. An HA can be a Monaural Hearing Aid, a Banded Hearing Aid, or a member of a Binaural Hearing Aid Set.
- **Hearing Aid Unicast Client (HAUC).** The HAUC role is implemented in a device capable of sending and optionally receiving unicast audio data to/from a hearing aid in the HA role. Examples of devices implementing the HAUC role are smartphones, tablets, laptops, personal microphones, music players, and voice recognition gateways.
- **Hearing Aid Remote Controller (HARC).** The HARC role is implemented in a device that controls volume levels of the different audio sources (e.g., ambient sound, telecoil, audio streams), mute state of a microphone, and presets of a hearing aid in the HA role. The HARC may also implement the functionalities required to assist an HA in synchronizing to a broadcast audio stream. This role can be implemented on remote controllers but may also coexist with the HAUC role on devices such as smartphones and tablets that wish to control the functionalities of the HA. If the HARC is the only HAP role implemented on a device, that device may not support the LE Isochronous Channels features defined in [1].
- **Immediate Alert Client (IAC).** A device implements the IAC role to capture the attention of the HA wearer. Examples of devices implementing the IAC role are smartphones, tablets, laptops, and home appliances.

This profile does not specify a role for transmitting broadcast audio streams using the LE Isochronous Channels feature, because there are no additional requirements beyond BAP and CAP.

### 2.2 Role/profile relationships

Table 2.1 shows the conformance requirements for HAP roles with CAP roles.

All IAC profile requirements are specified in Section 6.

| CAP Role  | HAP Roles |      |      |
|-----------|-----------|------|------|
|           | HA        | HAUC | HARC |
| Initiator | ✗E        | M    | ✗E   |
| Acceptor  | M         | ✗E   | ✗E   |
| Commander | ✗E        | ✗E   | M    |

Table 2.1: Conformance requirements for HAP roles with CAP roles

Table 2.2 shows the conformance requirements for HAP roles with other LE Audio profile roles. A dash in a table cell indicates that HAP makes no change to the requirement as specified in CAP. All other cells indicate requirements that are in addition to what is specified in CAP.

| LE Audio Profile Role      | HAP Roles |      |      |
|----------------------------|-----------|------|------|
|                            | HA        | HAUC | HARC |
| BAP Unicast Client         | –         | M    | –    |
| BAP Unicast Server         | M         | –    | –    |
| BAP Broadcast Sink         | M         | –    | –    |
| VCP Volume Controller      | –         | –    | M    |
| VCP Volume Renderer        | M         | –    | –    |
| MICP Microphone Controller | –         | –    | O    |
| MICP Microphone Device     | C.2       | –    | –    |
| CCP Call Control Client    | O         | ✗E   | ✗E   |
| CCP Call Control Server    | ✗E        | O    | ✗E   |
| CSIP Set Coordinator       | –         | M    | M    |
| CSIP Set Member            | C.1       | –    | –    |
| HAS Client <sup>1</sup>    | ✗E        | ✗E   | M    |
| HAS Server                 | M         | ✗E   | ✗E   |
| VAP Terminal               | O         | ✗E   | ✗E   |

<sup>1</sup> HAS Client and HAS Server refer to the GATT Client and GATT Server of the HAS, respectively. HAS Client behavior is specified in Section 5; HAS Server behavior is specified in [5].

| LE Audio Profile Role | HAP Roles     |      |               |
|-----------------------|---------------|------|---------------|
|                       | HA            | HAUC | HARC          |
| VAP Gateway           | <del>XE</del> | O    | <del>XE</del> |

Table 2.2: Conformance requirements for HAP roles with other LE Audio profiles' roles

C.1: Mandatory if the HA is capable of being part of a Binaural Hearing Aid Set; otherwise Excluded.

C.2: Mandatory if the HA supports the BAP Audio Source role (see Section 3.7); otherwise Excluded.

Additional requirements for the LE Audio profile roles in Table 2.2 are specified in Sections 3 to 5 for each HAP role. If a role is not mentioned in these sections, it means that the HAP does not specify additional requirements beyond the mandatory requirements specified in the corresponding profile specification.

## 2.3 Concurrency limitations/restrictions

This profile does not impose limitations/restrictions on any combination of roles that may be concurrently occupied by a device.

## 2.4 Topology limitations/restrictions

This profile does not impose additional topology limitation/restrictions beyond those defined by other profiles implemented on a device and referenced here.

## 2.5 Transport dependencies

This profile shall operate over an LE transport only.

## 3 Hearing Aid role requirements

The service requirements for the HA role are defined in the profiles mentioned in [Table 2.2](#). Section 3 specifies additional requirements beyond those defined in the profile specifications referenced by this profile.

### 3.1 Feature support

An HA may optionally support the following feature:

- **Volume Balance.** Volume balance means that different volume levels may be applied to left and right hearing aids. Volume balance and volume settings handled by VCP are generally independent of any audiological settings, which are manufacturer specific.

### 3.2 Requirements for Low Energy transport

This section describes requirements for the Low Energy transport.

The HA shall support the LE 2M PHY (Physical Layer).

To improve the performance of the mandatory LC3 codec at a 10 ms frame duration over a transport interval of 7.5 ms, an HA shall support the parameters in [Table 3.1](#) when accepting the establishment of a Connected Isochronous Stream (CIS) or synchronizing to a Broadcast Isochronous Stream (BIS).

An HA may support LC3 codec configurations with a 7.5 ms frame duration.

If the HA supports the BAP Audio Source role (see Section 3.7), and the HA has accepted the establishment of a CIS configured with the parameters shown in [Table 3.1](#), then the HA shall support sending unsegmented Service Data Units (SDUs) to prevent an undesirable increase of the frame loss rate (i.e., the HA sends one SDU in a given PDU).

| Parameter                                                                                      | Value                                                                                                                                                                                 |
|------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Flush Timeout (FT) (unicast)                                                                   | 1                                                                                                                                                                                     |
| Pre-Transmission Offset (PTO) (broadcast)                                                      | 0                                                                                                                                                                                     |
| Max_PDU_C_To_P <a href="#">[7]</a> (unicast),<br>Max_PDU_P_To_C <a href="#">[7]</a> (unicast), | >= Maximum size of an SDU that contains one LC3 Media Packet (see Section 4.2 in <a href="#">[3]</a> ) with codec frames at 10 ms frame duration plus 5 octets of framed ISOAL header |
| Max_PDU (broadcast)                                                                            | >= Maximum size of an SDU that contains one LC3 Media Packet with codec frames at 10 ms frame duration plus 5 octets of framed ISOAL header                                           |
| Framing                                                                                        | Framed                                                                                                                                                                                |
| BN                                                                                             | 1                                                                                                                                                                                     |

Table 3.1: Required parameters for unsegmented, framed Isochronous Adaptation Layer (ISOAL) support

The HA shall support accepting the establishment of a CIS and synchronizing to a BIS with the parameters in [Table 3.2](#).

| Parameter                                              | Value                                                                                                  |
|--------------------------------------------------------|--------------------------------------------------------------------------------------------------------|
| Flush Timeout (FT) (unicast)                           | 1                                                                                                      |
| Pre-Transmission Offset (PTO) (broadcast)              | 0                                                                                                      |
| Max_PDU_C_To_P (unicast),<br>Max_PDU_P_To_C (unicast), | >= Maximum size of an SDU that contains one LC3 Media Packet with codec frames at 10 ms frame duration |
| Max_PDU (broadcast)                                    | >= Maximum size of an SDU that contains one LC3 Media Packet with codec frames at 10 ms frame duration |
| Framing                                                | Unframed                                                                                               |
| BN                                                     | 1                                                                                                      |

*Table 3.2: Required parameters for unframed ISOAL support*

The maximum SDU size referred to in [Table 3.1](#) and [Table 3.2](#) is equal to the maximum size of the LC3 Media Packet that is supported by the HA (see Section 4.2 in [\[3\]](#)), and is calculated as:

Supported\_Max\_Codec\_Frames\_Per\_SDU \* (octets 2–3 of Supported\_Octets\_Per\_Codec\_Frame).

Supported\_Max\_Codec\_Frames\_Per\_SDU and Supported\_Octets\_Per\_Codec\_Frame are the values of the LTV structures defined in Bluetooth Assigned Numbers [\[2\]](#) and exposed in PAC (Published Audio Capabilities) records.

### 3.3 Service UUIDs AD Type

If the HA is in one of the Generic Access Profile (GAP) discoverable modes, the HA shall include the Hearing Access Service Universally Unique Identifier (UUID) defined in [\[2\]](#) in the Service UUID Advertising Data (AD) Type field of the advertising data or scan response data.

If the HA is in one of the GAP connectable modes and is using a resolvable private address, the HA shall not include the Hearing Access Service UUID in the Service UUID AD type field of the advertising data or scan response.

### 3.4 Appearance AD Type

If the HA is in one of the GAP discoverable modes, the HA may include the value of the Appearance characteristic in its advertising data or scan response data for an enhanced user experience.

If the HA is in one of the GAP connectable modes and is using a resolvable private address, the HA shall not include the value of the Appearance characteristic in its advertising data or scan response data.

## 3.5 Hearing Access Service requirements

### 3.5.1 HAS requirements

The HA shall instantiate one and only one instance of the HAS (see [5]).

### 3.5.2 Battery Service requirements

If the HA is equipped with one or more batteries, the HA should instantiate the Battery Service (BAS) (see [8]).

### 3.5.3 Immediate Alert Service requirements

The HA may instantiate one instance of the Immediate Alert Service (IAS) (see [10]).

When the value “High Alert” is written to the Alert Level characteristic, the HA shall alert the hearing aid wearer by using an appropriate audio alert.

When the value “Mild Alert” is written to the Alert Level characteristic, the HA should alert the hearing aid wearer by using an appropriate audio alert.

The duration of the alert is implementation specific.

## 3.6 CSIP Set Member role requirements

If the HA is part of a Binaural Hearing Aid Set, the HA shall satisfy the following requirements:

- The HA shall instantiate an instance of Coordinated Set Identification Service (CSIS),
- The HA shall support the Coordinated Set Size characteristic.

## 3.7 BAP Unicast Server role requirements

This section specifies additional mandatory requirements beyond those specified by BAP.

The HA shall support the BAP Audio Sink role.

The HA may support the BAP Audio Source role. By supporting the BAP Audio Source role, the HA can stream audio to the HAUC. In a Binaural Hearing Aid Set of two hearing aids, zero, one or both hearing aids may support this feature. When both hearing aids support this feature and audio streaming from the HA to the HAUC is required, the HAUC can decide to use both or only one of the hearing aids as a BAP Audio Source.

If the HA supports the BAP Audio Source role, the HA shall support the BAP Audio Source and BAP Audio Sink role concurrently and shall support the establishment of a bidirectional CIS with a HAUC.

If the HA implements the VAP Terminal Role [15], then the HA shall support the BAP Audio Source role.

If the HA is part of a Binaural Hearing Aid Set, the HA shall set at least one of the Front Left bit or the Front Right bit to a value of 0b1 in the Sink Audio Locations characteristic value as defined in [2].

A Banded Hearing Aid in the HA role shall set both the Front Left and the Front Right bits to the value of 0b1 in the Sink Audio Locations characteristic value.

This specification does not define any requirements for setting or define any behavior associated with the audio location bits that may be set in the Source Audio Locations characteristic that is included by a device implementing the HA role.

The HA shall support the Audio Capability Settings defined as mandatory for the Unicast Server role in Table 3.5 of BAP (see [3]). In addition, the HA shall support the corresponding mandatory Quality of Service (QoS) configuration requirements for the Unicast Server role specified in Table 5.2 of BAP (see [3]).

The HA should set to 0b1 at least **one of** the bits representing ‘Conversational’, ‘Media’, and ‘Live’ Context Types in the Supported\_Sink\_Contexts field of the Supported Audio Contexts characteristic in Published Audio Capabilities Service (PACS), in addition to the ‘Unspecified’ Context Type mandated by BAP. **If the HA implements the VAP Terminal Role [15], then the HA shall include the “Voice Assistants” Context Type value [2] in the Supported\_Sink\_Contexts field and in the Supported\_Source\_Contexts field.** The values of Context Types are defined in [2].

The HA shall support a Presentation Delay range in the Codec Configured state that includes the value of 20ms, in addition to the requirement specified in Table 5.2 of [3].

### 3.8 BAP Broadcast Sink role requirements

The HA shall be capable of rendering audio streams that use a mandatory LC3 configuration from Table 3.11 of BAP no later than 20ms after the SDU Synchronization reference (see Section 7.1.1 of [3]).

### 3.9 Volume Renderer role requirements

This section specifies additional mandatory requirements beyond those specified by VCP.

The Volume Control Service (VCS) is used to expose the volume level of the audio at the hearing aid speaker (also known as the receiver in hearing aid terminology). How the Volume State characteristic affects the internal volume control of a hearing aid is implementation specific. It could act as the overall volume control or it could operate on other volume levels as well; for example, it could control only the volume level of a received audio stream.

An HA may instantiate one or more instances of Audio Input Control Service (AICS) to expose control of the gain of its inputs to a Volume Controller.

For example, if an HA intends to expose the volume level of the sound captured by its microphone, the volume level of the sound captured by an IEC 60118-4 compliant audio-frequency induction loop, (commonly known as a telecoil), and the volume level of Audio Streams as defined in [3], then it will instantiate three instances of AICS with the value of the Audio Input Description characteristics set to Microphone, Telecoil, and Bluetooth LE Audio, respectively. This example is depicted in [Figure 3.1](#) where solid lines represent audio flow and dashed lines represent GATT include definitions between services.

If the HA supports the Volume Balance feature (see Section 3.1) and the HA is part of a Binaural Hearing Aid Set, the HA shall instantiate one instance of Volume Offset Control Service (VOCS).

If the HA supports the Volume Balance feature (see Section 3.1) and the HA is a Banded Hearing Aid, the HA shall instantiate two instances of VOCS.

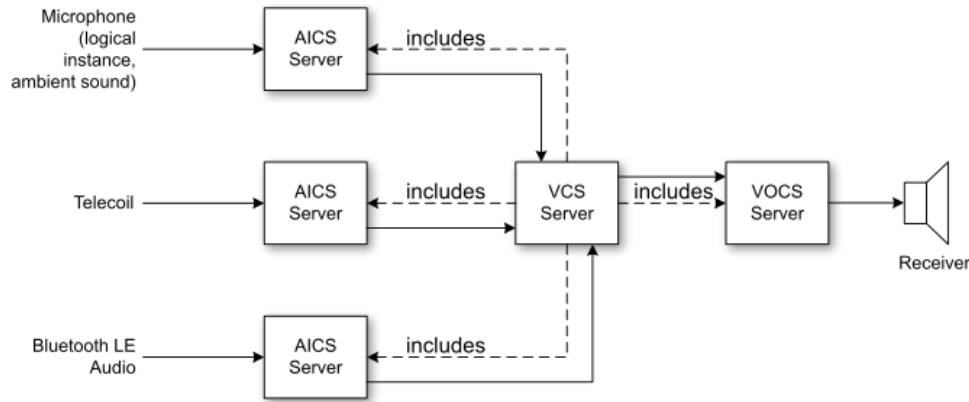


Figure 3.1: Example of VCS, AICS, and VOCS in an HA

### 3.10 MICP Device role requirements

If the HA supports the BAP Audio Source role (see Section 3.7), the HA shall expose one instance of the Microphone Input Control Service (MICS), and optionally one instance of AICS, to enable the peer device in the MICP Microphone Controller role to mute/unmute the microphone that picks up the user's voice.

The HA may expose an instance of MICS and an instance of AICS to control the capture of ambient sound.

## 4 Hearing Aid Unicast Client role requirements

Section 4 specifies additional requirements beyond those defined in the profile specifications referenced by this profile in [Table 2.2](#).

### 4.1 Requirements for Low Energy transport

This section describes requirements for the Low Energy transport.

The HAUC shall support the LE 2M PHY.

To provide interoperability with a device in the HA role that does not support an LC3 codec configuration with a 7.5 ms frame duration, a device in the HAUC role shall support establishing an isochronous stream with the parameters listed in [Table 4.1](#). These parameters make it possible to avoid segmentation of SDUs and avoid an undesirable increase of the frame loss rate.

According to the Bluetooth Core Specification v5.2 [\[1\]](#), it is possible to avoid segmentation when framed ISOAL is used for unicast or broadcast Audio Streams by setting an appropriate Max\_PDU value. The maximum value for Max\_PDU is the maximum payload size of an Isochronous Physical Channel PDU that is 251 octets (see Volume 6, Part B, Section 2.6 in [\[1\]](#)).

| Parameter                                             | Value                                                                                                                                                                                 |
|-------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Flush Timeout (FT)                                    | 1                                                                                                                                                                                     |
| Max_PDU_C_To_P (unicast),<br>Max_PDU_P_To_C (unicast) | >= Maximum size of an SDU that contains one LC3 Media Packet (see Section 4.2 in <a href="#">[3]</a> ) with codec frames at 10 ms frame duration plus 5 octets of framed ISOAL header |
| Framing                                               | Framed                                                                                                                                                                                |
| BN                                                    | 1                                                                                                                                                                                     |

Table 4.1: Required parameters for unsegmented, framed ISOAL support

The maximum SDU size referred to in [Table 4.1](#) is equal to the maximum size of the LC3 Media Packet (see Section 4.2 in [\[3\]](#)) that is supported by the HAUC, and can be calculated as

$$(\text{Octets\_Per\_Codec\_Frame} * (\text{number of bits set to a value of 0b1 in Audio\_Channel\_Allocation}) * \text{Codec\_Frame\_Blocks\_Per\_SDU}).$$

Octets\_Per\_Codec\_Frame, Audio\_Channel\_Allocation, and Codec\_Frame\_Blocks\_Per\_SDU are the values of the LTV structures defined in Bluetooth Assigned Numbers [\[2\]](#).

## 4.2 Service discovery

The HAUC shall perform Primary Service Discovery on the HA by using either the GATT Discover All Primary Services sub-procedure or the GATT Discover Primary Services by Service UUID sub-procedure.

The HAUC shall discover the Hearing Access Service.

## 4.3 BAP Unicast Client role requirements

This section specifies additional mandatory requirements beyond those specified by BAP.

The HAUC shall support the BAP Audio Source role.

The HAUC shall support the Codec Configuration Settings defined as mandatory for the Unicast Client role in Table 3.11 of BAP (see [3]) and the corresponding mandatory QoS configuration requirements for the Unicast Client role specified in Table 5.2 of BAP (see [3]).

The HAUC shall support establishing two unicast Audio Streams: one for the Front Left Audio Location and one for the Front Right Audio Location (i.e., a CIG with two unidirectional CISes). Each Audio Stream transports one Audio Channel from the HAUC to each of the two HAs of a Binaural Hearing Aid Set, or to a Banded Hearing Aid.

Note: The HAUC can optionally support sending two Audio Channels in one unicast Audio Stream as specified in BAP (see Section 4 in [3]).

If the HAUC supports the CCP Call Control Server role or the VAP Voice Assistant Gateway (VAG) [15], it shall support at least one bidirectional CIS and the BAP Audio Sink role. The HAUC should use a bidirectional CIS instead of two CISes in opposite directions to optimize bandwidth usage and power consumption.

## 5 Hearing Aid Remote Controller role requirements

Section 5 specifies additional requirements beyond those defined in the profile specifications referenced by this profile in [Table 2.2](#).

### 5.1 Requirements for Low Energy transport

This section describes the requirements when using this profile over the Low Energy transport.

The HARC shall support the LE 2M PHY.

### 5.2 Service discovery requirements

The HARC shall discover the Hearing Access Service.

### 5.3 Characteristic discovery

The HAS characteristic discovery requirements are listed in [Table 5.1](#).

| Characteristic                   | Discovery requirement for HARC |
|----------------------------------|--------------------------------|
| Hearing Aid Features             | C.2                            |
| Hearing Aid Preset Control Point | C.1                            |
| Active Preset Index              | O                              |

Table 5.1: Characteristic discovery requirements for HARC

C.1: Mandatory if the HARC supports the Active Preset Index characteristic; otherwise Optional.

C.2: Mandatory if the HARC supports the Preset Control Point characteristic; otherwise Excluded.

### 5.4 Hearing Aid Features characteristic requirements

If the HARC supports the Hearing Aid Features characteristic and if the HA supports notifications of this characteristic, then the HARC shall register for notifications.

### 5.5 Hearing Aid Preset Control Point characteristic requirements

If the HARC supports the Preset Control Point characteristic and the Read Preset procedure and an enhanced ATT bearer exists between the client and the server, then the HARC shall register for indications and may register for notifications of this characteristic.

If the HARC supports the Preset Control Point characteristic and the Read Preset procedure and only the unenhanced ATT bearer exists between the client and the server, then the HARC shall register for indications of this characteristic.

The procedures specified in this section are used by a HARC to control the presets on an HA.

An HA may not support all opcodes of the Hearing Aid Preset Control Point characteristic. The HARC shall read the Hearing Aid Features characteristic to determine which opcodes are supported (see [5]).

If the HARC supports the Preset Control Point characteristic, the HARC shall satisfy the support requirements for the HAP procedure listed in Table 5.2.

| Procedure                                            | Reference     | Requirement for HARC |
|------------------------------------------------------|---------------|----------------------|
| Read Presets Request procedure                       | Section 5.5.1 | C.1                  |
| Preset Changed procedure                             | Section 5.5.2 | C.1                  |
| Write Preset Name procedure                          | Section 5.5.3 | O                    |
| Set Active Preset procedure                          | Section 5.5.4 | C.3                  |
| Set Next Preset procedure                            | Section 5.5.5 | C.3                  |
| Set Previous Preset procedure                        | Section 5.5.6 | C.3                  |
| Set Active Preset – Synchronized Locally procedure   | Section 5.5.7 | C.4                  |
| Set Next Preset – Synchronized Locally procedure     | Section 5.5.8 | C.5                  |
| Set Previous Preset – Synchronized Locally procedure | Section 5.5.9 | C.6                  |

Table 5.2: Procedure support requirements for HARC

- C.1: Mandatory if the HARC supports the Set Active Preset procedure OR Write Preset Name procedure; otherwise Optional.
- C.2: Mandatory if the HARC supports the Active Preset Index characteristic; otherwise Optional.
- C.3: Mandatory for the HARC to support at least one of these procedures.
- C.4: Mandatory if the HARC supports the Set Active Preset procedure; otherwise Excluded.
- C.5: Mandatory if the HARC supports the Set Next Preset procedure; otherwise Excluded.
- C.6: Mandatory if the HARC supports the Set Previous Preset procedure; otherwise Excluded.

Before executing the Write Preset Name procedure, the Set Active Preset procedure, or the Set Active Preset – Synchronized Locally procedure, the HARC shall execute the Read Presets Request procedure to read the preset records exposed by the server or use the most recent cached value of the list of preset records.

If the HARC supports the Read Presets Request procedure, then the HARC shall support an ATT\_MTU value no less than 49.

When a procedure from Table 5.2 is composed of more than one ATT PDU exchange, the HARC shall consider the procedure as failed if the ATT bearer is terminated before all the ATT PDUs have been

exchanged, or if the HA is unresponsive for an application-defined amount of time. When a procedure from [Table 5.2](#) fails, the HARC may try again to execute the procedure after an application-defined amount of time.

If only one HA of a Binaural Hearing Aid Set is available at the time the HARC intends to execute any of the procedures in [Table 5.2](#), except for Write Preset Name procedure, the HARC should execute the procedure with the available HA. An HARC can consider an HA as available when one of the following statements is true:

- The HARC and the HA are connected.
- The HARC and the HA are not connected, the HA is advertising in one of the GAP Connectable modes, and the HA is in range of the HARC.

The HARC shall not execute the Write Preset Name procedure when only one HA of the Binaural Hearing Aid Set is available.

The two HAs of a Binaural Hearing Aid Set may expose different preset records. In this case, the Independent Presets flag will be set to 0b1, and the HARC will control the presets on the two HAs independently, as defined in Sections [5.5.3](#) to [5.5.6](#).

### 5.5.1 Read Presets Request procedure

The Read Presets Request procedure is used to read a variable number of preset records exposed by the server.

To execute the Read Presets Request procedure, the HARC shall write the Read Presets Request opcode to the Hearing Aid Preset Control Point characteristic, followed by a StartIndex and a NumPresets value which defines the number of records to be read.

The HARC will receive a Write Response followed by one or more notifications or indications of the Hearing Aid Preset Control Point characteristic with the Read Preset Response opcode. Each of these notifications or indications that the HARC receives contains one preset record. If the isLast characteristic is set to 0x01, the HARC shall then consider the Read Presets Request procedure complete.

### 5.5.2 Preset Changed procedure

An HA indicates support for changes to the list of preset records by setting the Dynamic Presets field of the Hearing Aid Features characteristic to 0b1. The HA will inform the HARC about any change using the Preset Changed opcode (see [\[5\]](#)).

### 5.5.3 Write Preset Name procedure

The Write Preset Name procedure is used to assign a human-readable name to one of the writable preset records exposed by the HA.

To execute the Write Preset Name procedure, the HARC shall write the Write Preset Name opcode, followed by the Index parameter and the Name parameter to the Hearing Aid Preset Control Point characteristic.

The HARC shall execute this procedure with both HAs that are part of a Binaural Hearing Aid Set if the Independent Presets flag is set to 0b0, and the HARC shall use the same parameter values during both executions.

#### **5.5.4 Set Active Preset procedure**

The Set Active Preset procedure is used to instruct the HA to change the active preset to another preset among those exposed in the list of preset records.

To execute the Set Active Preset procedure, the HARC shall write the Set Active Preset opcode followed by the Index parameter to the Hearing Aid Preset Control Point characteristic.

The HARC shall not set the Index parameter to the Index of a preset record that has the `isAvailable` field set to 0b0 (the preset is unavailable), or to an Index value that is not supported by the HA.

The HARC shall execute this procedure with both HAs that are part of a Binaural Hearing Aid Set if the Independent Presets flag is set to 0b0, and the HARC shall use the same parameter values during both executions.

#### **5.5.5 Set Next Preset procedure**

The Set Next Preset procedure is used to instruct the HA to change the active preset to the next preset from the list of preset records. If the active preset is the last in the list of preset records, this procedure sets the active preset to the first entry of the list of preset records.

To execute the Set Next Preset procedure, the HARC shall write the Set Next Preset opcode to the Hearing Aid Preset Control Point characteristic.

The HARC shall execute this procedure with both HAs that are part of a Binaural Hearing Aid Set if the Independent Presets flag is set to 0b0, and the HARC shall use the same parameter values during both executions.

#### **5.5.6 Set Previous Preset procedure**

The Set Previous Preset procedure is used to instruct the HA to change the active preset to the previous preset from the list of preset records. If the active preset is the first in the list of preset records, this procedure sets the active preset to the last entry of the list of preset records.

To execute the Set Previous Preset procedure, the HARC shall write the Set Previous Preset opcode to the Hearing Aid Preset Control Point characteristic.

The HARC shall execute this procedure with both HAs that are part of a Binaural Hearing Aid Set if the Independent Presets flag is set to 0b0, and the HARC shall use the same parameter values during both executions.

### 5.5.7 Set Active Preset – Synchronized Locally procedure

The Set Active Preset – Synchronized Locally procedure is used to instruct a member of the Binaural Hearing Aid Set to change the active preset to another preset among those exposed in the list of preset records.

To execute the Set Active Preset – Synchronized Locally procedure, the HARC shall write the Set Active Preset – Synchronized Locally opcode followed by the Index parameter to the Hearing Aid Preset Control Point characteristic. The HARC shall execute this procedure with only one member of the Binaural Hearing Aid Set.

The HARC shall not execute this procedure with an HA that has the Preset Synchronization Support field of the Hearing Aid Features characteristic set to 0b0.

### 5.5.8 Set Next Preset – Synchronized Locally procedure

The Set Next Preset – Synchronized Locally procedure is used to instruct one member of the Binaural Hearing Aid Set to change the active preset to the next preset from the list of preset records. If the active preset is the last in the list of preset records, this procedure sets the active preset to the first entry of the list of preset records.

To execute the Set Next Preset – Synchronized Locally procedure, the HARC shall write the Set Next Preset – Synchronized Locally opcode to the Hearing Aid Preset Control Point characteristic. The HARC shall execute this procedure with only one member of the Binaural Hearing Aid Set.

The HARC shall not execute this procedure with an HA that has the Preset Synchronization Support field of the Hearing Aid Features characteristic set to 0b0 (i.e., Preset Synchronization is not supported).

### 5.5.9 Set Previous Preset – Synchronized Locally procedure

The Set Previous Preset – Synchronized Locally procedure is used to instruct one member of the Binaural Hearing Aid Set to change the active preset to the previous preset from the list of preset records. If the active preset is the first in the list of preset records, this procedure sets the active preset to the last entry of the list of preset records.

To execute the Set Previous Preset – Synchronized Locally procedure, the HARC shall write the Set Previous Preset – Synchronized Locally opcode to the Hearing Aid Preset Control Point characteristic. The HARC shall execute this procedure with only one member of the Binaural Hearing Aid Set.

The HARC shall not execute this procedure with an HA that has the Preset Synchronization Support field of the Hearing Aid Features characteristic set to 0b0 (i.e., Preset Synchronization is not supported).

## 5.6 Active Preset Index characteristic requirements

If the HARC supports the Active Preset Index characteristic, then the HARC shall register for notifications of this characteristic.

The HARC may use the Read Presets Request procedure to retrieve the name of the active preset after reading the Active Preset Index characteristic or receiving a notification of the Active Preset Index characteristic.

## 6 Immediate Alert Client role requirements

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### 6.1 Service discovery

The IAC shall perform primary service discovery on the HA by using either the GATT Discover All Primary Services sub-procedure or the GATT Discover Primary Services by Service UUID sub-procedure to discover the Immediate Alert Service.

### 6.2 Characteristic discovery

The IAC shall use either the GATT Discover All Characteristics of a Service sub-procedure or the GATT Discover Characteristics by UUID sub-procedure to discover the Alert Level characteristic.

### 6.3 Alert Level characteristic

If a device supports the IAC role and supports the HAUC role, and the HAUC fails to set up audio streams because of the non-availability of the HA for a particular Context Type value, as described in Section 7.3.1.2.1 of CAP (see [4]), the IAC should send an appropriate level of alert to the HA by writing a “Mild Alert” or “High Alert” value to the Alert Level characteristic to gain the attention of the hearing aid wearer.

A device that supports the IAC role and the HAUC role and the CCP Client role should inform an HA that does not support the CCP Client role of an incoming call by writing a “Mild Alert” or “High Alert” value to the Alert Level characteristic to gain the attention of the hearing aid wearer. The hearing aid wearer can then accept the incoming call on the HAUC device.

When the IAC role is implemented on a device that does not support the HAUC role, the IAC should send an appropriate level of alert to the HA by writing a “Mild Alert” or “High Alert” value to the Alert Level characteristic to gain the attention of the hearing aid wearer. For example, a doorbell that does not support audio streaming can connect and write “High Alert” to the Alert Level characteristic.

## 7 Connection establishment procedures

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The connection establishment procedures for the HA, HAUC, and HARC roles are defined in CAP [\[4\]](#).

The IAC shall use the connection establishment procedures specified in GAP (see Volume 3, Part C, Section 9 in [\[9\]](#)).

HAUC and HARC shall use the discovery procedures defined in CSIP for the Set Coordinator role to discover Binaural Hearing Aid Set members.

## 8 Security considerations

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### 8.1 HA security considerations for Low Energy

The security requirements for all characteristics specified by HAS and IAS shall be set to LE Security Mode 1 Level 2 (see Volume 3, Part C, Section 10.2.1 in [1]).

Access to all characteristics defined in HAS and IAS shall require an encryption key with at least 128 bits of entropy, derived from any of the following:

- LE Secure Connections
- BR/EDR Secure Connections (if Cross-Transport Key Derivation is used)
- Out of Band method

Other security requirements are specified in the profile specifications referred to in Table 2.2 for the HA role.

### 8.2 HAUC security considerations for Low Energy

Security requirements are specified in the profile specifications referred to in Table 2.2 for the HAUC role.

### 8.3 HARC security considerations for Low Energy

Security requirements are specified in the profile specifications referred to in Table 2.2 for the HARC role.

### 8.4 IAC security considerations for Low Energy

The IAC shall support Bondable mode, defined in Volume 3, Part C, Section 9.4.3 in [9].

The IAC should support the Bonding procedure defined in Volume 3, Part C, Section 9.4.4 in [9].

The IAC should accept the LE Security mode and the LE Security Level combination that is requested by the HA.

If the IAC is using Privacy, the IAC shall distribute its Identity Address and Identity Resolving Key (IRK) [9].

## 9 Acronyms and abbreviations

| Acronym/Abbreviation | Meaning                                |
|----------------------|----------------------------------------|
| AICS                 | Audio Input Control Service            |
| BAP                  | Basic Audio Profile                    |
| CAP                  | Common Audio Profile                   |
| CCP                  | Call Control Profile                   |
| CSIP                 | Coordinated Set Identification Profile |
| CSIS                 | Coordinated Set Identification Service |
| GAP                  | Generic Access Profile                 |
| HA                   | Hearing Aid (the profile role)         |
| HAP                  | Hearing Access Profile                 |
| HARC                 | Hearing Aid Remote Controller          |
| HAS                  | Hearing Access Service                 |
| HAUC                 | Hearing Aid Unicast Client             |
| IAC                  | Immediate Alert Client                 |
| IAS                  | Immediate Alert Service                |
| LC3                  | Low Complexity Communication Codec     |
| MICP                 | Microphone Control Profile             |
| PAC                  | Published Audio Capabilities           |
| PACS                 | Published Audio Capabilities Service   |
| UUID                 | Universally Unique Identifier          |
| <u>VAP</u>           | <u>Voice Assistant Profile</u>         |
| <u>VAS</u>           | <u>Voice Assistant Service</u>         |

| Acronym/Abbreviation | Meaning                       |
|----------------------|-------------------------------|
| VCP                  | Volume Control Profile        |
| VCS                  | Volume Control Service        |
| VOCS                 | Volume Offset Control Service |

Table 9.1: Acronyms and abbreviations

## 10 References

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- [1] Bluetooth Core Specification (~~amended~~), Version 5.2 or later
- [2] Bluetooth SIG Assigned Numbers, <https://www.bluetooth.com/specifications/assigned-numbers/>
- [3] Basic Audio Profile Specification, Version 1 or later
- [4] Common Audio Profile Specification, Version 1 or later
- [5] Hearing Access Service Specification, Version 1 or later
- [6] Coordinated Set Identification Profile Specification, Version 1 or later
- [7] Appropriate Language Mapping Table, <https://www.bluetooth.com/language-mapping/Appropriate-Language-Mapping-Table>
- [8] Battery Service Specification, Version 1 or later
- [9] Bluetooth Core Specification, Version 4.2 or later
- [10] Immediate Alert Service Specification, Version 1 or later
- [11] Volume Control Profile Specification, Version 1 or later
- [12] Microphone Control Profile Specification, Version 1 or later
- [13] Call Control Profile Specification, Version 1 or later
- ~~[14]~~ Published Audio Capabilities Service Specification, Version 1 or later
- ~~[15]~~ Voice Assistant Profile, Version 1.0 or later
- ~~[14]~~~~[16]~~ Voice Assistant Service, Version 1.0 or later