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Hands-Free Profile

Adopted Version 1.0

Abstract

The Hands-Free Profile (HFP) specification defines the minimum set of functions such that a Mobile Phone can be used in conjunction with a Hands-Free device (e.g. installed in the car), with a Bluetooth Link providing a wireless means for both remote control of the Mobile Phone by the Hands-Free device and voice connections between the Mobile Phone and the Hands-Free device.

Compliance with this specification assures interoperability between a Bluetooth enabled Hands-Free device and any Bluetooth equipped Mobile Phone supporting this profile.

Special Interest Group (SIG)

The following companies are represented in the Bluetooth Special Interest Group:

3Com Corp.
IBM Corp.
Intel Corp.
Agere Systems
Microsoft Corp.
Motorola Corp.
Nokia Corp.
Telefonaktiebolaget LM Ericsson.
Toshiba Corp.

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Contents

1 Introduction

1.1 Scope

This document defines the protocols and procedures that shall be used by devices implementing the Hands-Free Profile. The most common examples of such devices are Hands-Free units used together with cellular phones.

The profile defines how two devices supporting the Hands-Free Profile can interact with each other on a point-to-point basis.

An implementation of the Hands-Free Profile typically enables a car's embedded Hands-Free unit to be wirelessly connected to a cellular phone for the purposes of acting as the cellular phone's audio input and output mechanism, providing full duplex audio and perhaps combinations of voice recognition, noise suppression, and acoustic echo cancellation.

1.2 Profile Dependencies

In Figure 1.1, the Bluetooth profile structure and the dependencies of the profiles are depicted. A profile is dependent upon another profile if it re-uses parts of that profile, by explicitly referencing it. Dependency is illustrated in the figure below.
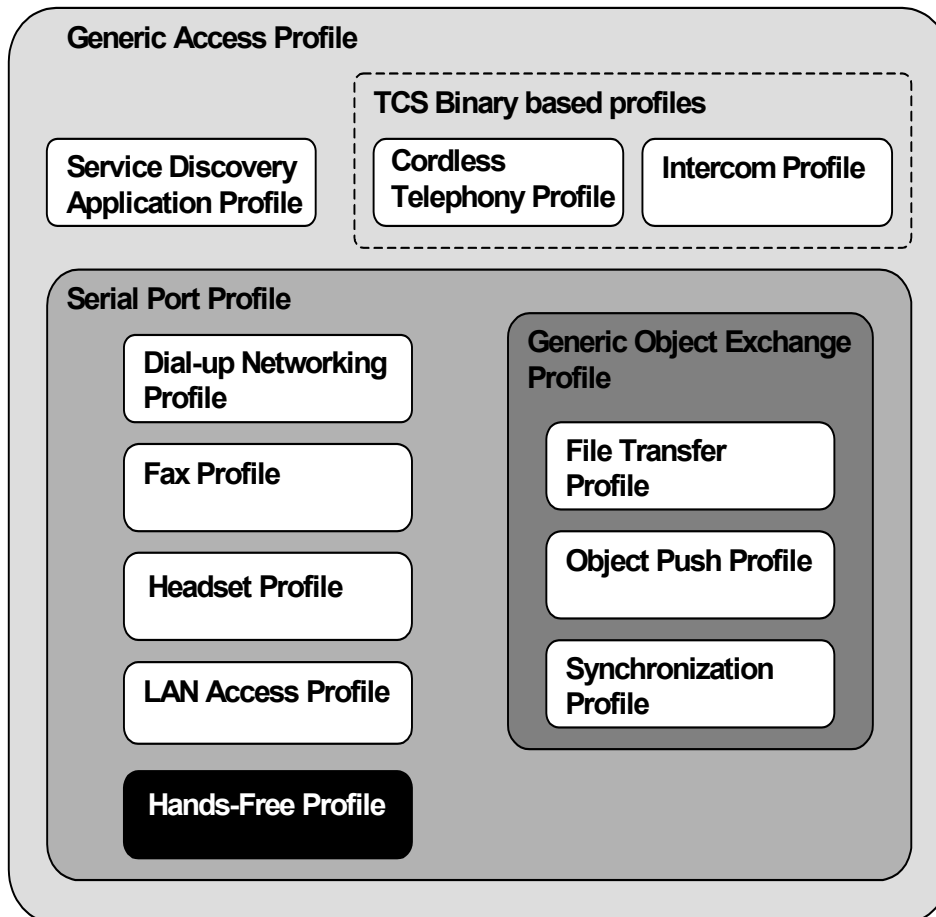
Figure 1.1 Bluetooth Profiles

As indicated in the figure, the Hands-Free Profile is dependent upon both the Serial Port Profile [6] and the Generic Access Profile [5]. Details are provided in Sections 5 (Serial Port Profile) and 6 (Generic Access Profile).

1.3 Symbols and Conventions

1.3.1 Requirement Status Symbols

In this document, the following symbols are used:

- "M" for mandatory to support

- "O" for optional to support

- "X" for excluded (used for capabilities that may be supported by the device, but the Hands-Free Profile shall not use these capabilities)

- "C" for conditional to support

- "N/A" for not applicable (in the given context this capability is not defined)

Some capabilities or features (identified as "X"), mandated according to the relevant Bluetooth specifications, are excluded with respect to this profile because they may degrade the operation of devices in the particular use case. Therefore, features or capabilities labeled "X" shall never be activated while operating in a use case where they are labeled as such.

1.3.2 Naming Conventions

In this document, the following naming conventions are used:

- Where "LMP link" is said, it means a Link Manager (LM) level link over which only Link Manager Protocol (LMP) commands are conveyed.

- Where "RFCOMM connection" is said, it means the presence of a virtual serial port as specified in [6].

- Where "Service Level Connection" is said, it means a synchronized high-level protocol connection involving a portion of the protocol stack. In this specific case, it refers to the presence of a RFCOMM connection, and assumes that the HF has synchronized itself to the state of the AG using the specified Service Level Connection initialization procedure.

- Where "Service Level Connection initialization" is said, it means the execution of the set of AT commands and responses specified by the profile necessary to synchronize the state of the HF with that of the AG.

- Where "Service Level Connection establishment" is said, it means the combined process of establishing the RFCOMM connection, as well as the necessary device synchronization using Service Level Connection initialization.

- Where "SCO link" is said, it means a low level Synchronous Connection Oriented (SCO) link intended for supporting a full duplex Audio Connection.

- Where "Audio Connection" is said, it means an SCO link plus all the means necessary to provide a complete audio path between both roles in the profile.

- Where "incoming call" is said, it means a call connection in the direction "Cellular Network=>AG", such that it is initiated by the Network to which the AG is attached.

- Where 'outgoing call' is said, it means a call connection in the direction "AG=>Cellular Network", such that it is initiated by the AG towards the Network to which it is attached.

1.3.3 Signaling Diagram Conventions

The signaling diagrams in this specification are informative only. Within the diagrams, the following conventions are used to describe procedures:
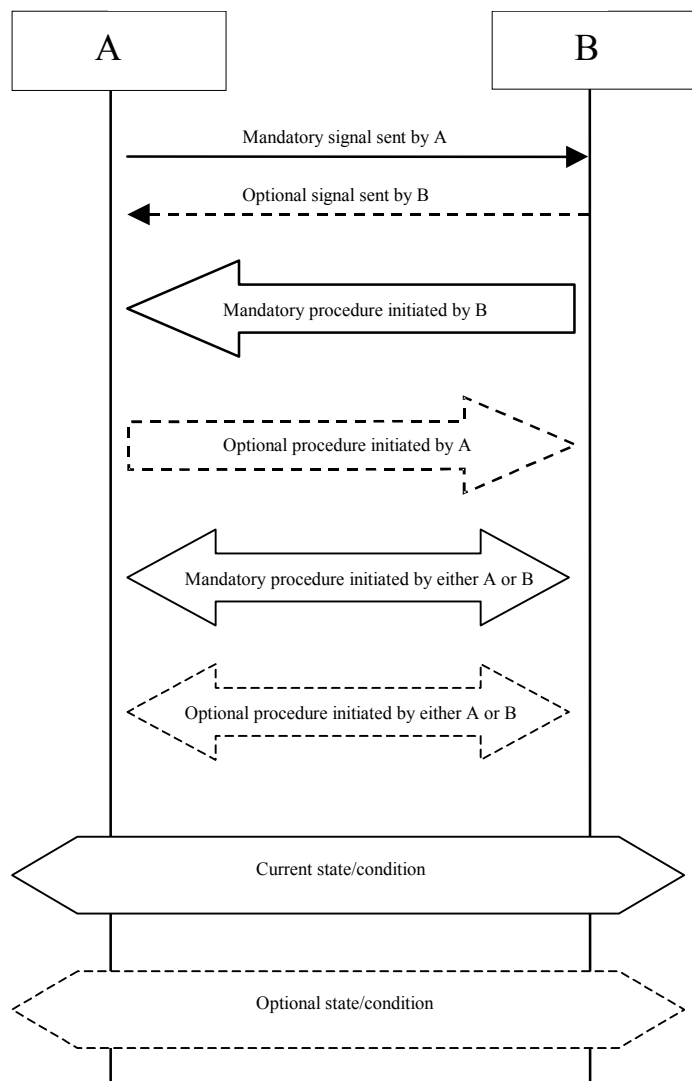
Figure 1.2 Conventions used in signaling diagrams

2 Profile Overview

2.1 Protocol Stack

The figure below shows the protocols and entities used in this profile.

Audio Gateway side   **Hands-Free side**
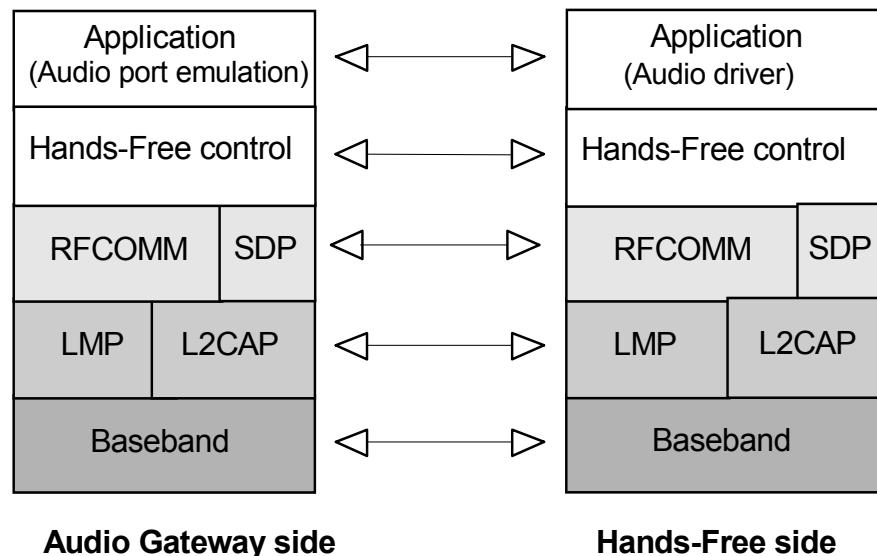
Figure 2.1 Protocol stack

The Baseband, LMP and L2CAP are the OSI layer 1 and 2 Bluetooth
protocols. RFCOMM is the Bluetooth serial port emulation entity. SDP is the
Bluetooth Service Discovery Protocol. See [1] for more details on these topics.

Compatibility to the current Bluetooth Core specification 1.1 (see [1]) is
mandated.

Hands-Free control is the entity responsible for Hands-Free unit specific
control signaling; this signaling is AT command based.

Although not shown in the model above, it is assumed by this profile that
Hands-Free Control has access to some lower layer procedures (for example,
SCO link establishment).

The audio port emulation layer shown in Figure 2.1 is the entity emulating the
audio port on the Audio Gateway, and the audio driver is the driver software in
the Hands-Free unit.

For the shaded protocols/entities in Figure 2.1, the Serial Port Profile [6] is
used as the base standard. For these protocols, all mandatory requirements

Bluetooth

stated in the Serial Port Profile apply except in those cases where this specification explicitly states deviations.

2.2 Configuration and Roles

The figure below shows a typical configuration of devices for which the Hands-Free Profile is applicable:
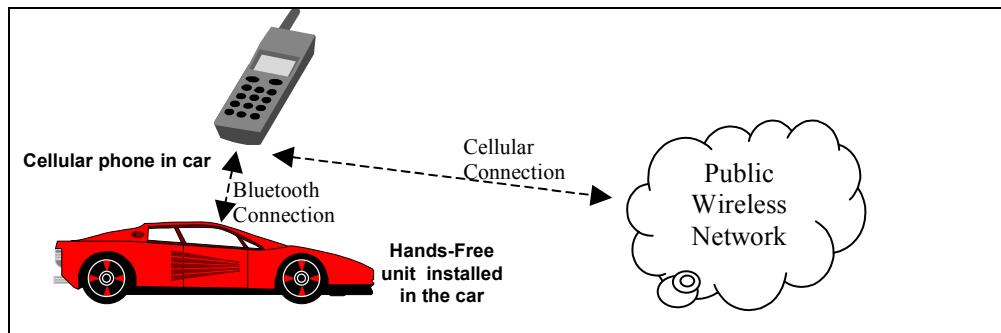
Figure 2.2 Hands-Free Profile: Example with the Hands-Free unit installed in the car

The following roles are defined for this profile:

Audio Gateway (AG) – This is the device that is the gateway of the audio, both for input and output. Typical devices acting as Audio Gateways are cellular phones.

Hands-Free unit (HF) – This is the device acting as the Audio Gateway's remote audio input and output mechanism. It also provides some remote control means.

These terms are used in the rest of this document to designate these roles.

2.3 User Requirements and Scenarios

The following rules apply to this profile:

a) The profile states the mandatory and optional features when the "Hands-Free Profile" is active in the Audio Gateway and the Hands-Free unit.

b) The profile mandates the usage of CVSD for transmission of audio (over the Bluetooth link). The resulting audio is monophonic, with a quality that, under normal circumstances, does not have perceived audio degradation.

c) Between the Hands-Free unit and the Audio Gateway, only one Audio Connection at a time is supported.

d) Both the Audio Gateway and the Hands-Free unit may initiate Audio Connection establishment and release. Valid speech data shall exist on the SCO link in both directions after the Audio Connection is established.

e) Whenever an "Audio Connection" exists, a related "Service Level Connection" shall also exist.

f) The presence of a "Service Level Connection" shall not imply that an "Audio Connection" exists. Releasing a "Service Level Connection" shall also release any existing "Audio Connection" related to it.

2.4 Profile Fundamentals

Baseband authentication and encryption is optional for both the Hands-Free unit and the Audio Gateway. If both devices support authentication and encryption, the application on either device may require its use.

A Hands-Free unit may be able to use the services of the Audio Gateway without the creation of a secure connection. It is implementation specific whether the Hands-Free unit provides/supports security enforcement for the user.

Whenever baseband authentication and/or encryption is used, the two devices shall create a secure connection using the GAP authentication procedure as described in Section 5.1 of the Generic Access Profile [5]. This procedure may include entering a PIN code and creation of proper link keys. In cases when the UI of the Hands-free unit is limited, a fixed PIN code may be used during the GAP authentication procedure.

If a LMP link is not already established between the Hands-Free unit and the Audio Gateway, the LMP link shall be set-up before any other procedure is performed.

There are no fixed master or slave roles in this profile.

The Audio Gateway and Hands-Free unit provide serial port emulation. For the serial port emulation, RFCOMM (see [1]) is used. The serial port emulation is used to transport the user data including modem control signals and AT commands from the Hands-Free unit to the Audio Gateway. AT commands are parsed by the Audio Gateway and responses are sent to the Hands-Free unit via the Bluetooth serial port connection.

2.5 Conformance

If conformance to this profile is claimed, all capabilities indicated as mandatory for this profile shall be supported in the specified manner (process mandatory). This also applies for all optional and conditional capabilities for which support is indicated. All mandatory, optional and conditional capabilities, for which support is indicated, are subject to verification as part of the Bluetooth Qualification Program.

Bluetooth

3 Application layer

This section describes the feature requirements on units complying with the Hands-Free Profile.

Table 3.1 below shows the feature requirements for this profile.

	Feature	Support in HF	Support in AG
1.	Connection management	M	M
2.	Phone status information	M[note 1]	M
3.	Audio Connection handling	M	M
4	Accept an incoming voice call	M	M
5.	Reject an incoming voice call	M	O
6.	Terminate a call	M	M
7.	Audio Connection transfer during an ongoing call	M	M
8.	Place a call with a phone number supplied by the HF	O	M
9.	Place a call using memory dialing	O	M
10.	Place a call to the last number dialed	O	M
11.	Call waiting notification	O	M
12.	Three way calling	O[note 2]	O[note 3]
13.	Calling Line Identification (CLI)	O	M
14.	Echo canceling (EC) and noise reduction (NR)	O	O
15.	Voice recognition activation	O	O
16.	Attach a Phone number to a voice tag	O	O
17.	Ability to transmit DTMF codes	O	M
18.	Remote audio volume control	O	O

Note 1: The HF shall support at least the two indicators "service" and "call".

Note 2: If "Three way calling" is supported by the HF, it shall support AT+CHLD values 0, 1, 2 and 3. The HF may additionally support AT+CHLD value 4.

Note 3: If "Three way calling" is supported by the AG, it shall support AT+CHLD values 0, 1, 2, 3 and 4

Table 3.1 Application layer procedures

Table 3.2 below maps each feature to the procedures used for that feature. All procedures are mandatory if the feature is supported.

	Feature	**Procedure**	**Ref.**
1.	Connection management	Service Level Connection establishment	4.2
		Service Level Connection release	4.3
2.	Phone status information	Transfer of Registration Status	4.4
		Transfer of Call and Call Setup Status	4.5
3.	Audio Connection handling	Audio Connection set up	4.6
		Audio Connection release	4.7
4.	Accept an incoming voice call	Answer an incoming call	4.8
5.	Reject an incoming voice call	Reject an incoming call	4.9
6.	Terminate a call	Terminate a call process	4.10
7.	Audio Connection transfer during an ongoing call	Audio Connection transfer towards the HF	4.11
		Audio Connection transfer towards the AG	4.12
8.	Place a call with the phone number supplied by the HF	Place a call with the phone number supplied by the HF	4.13
9	Place a call using memory dialing	Memory dialing from the HF	4.14
10	Place a call to the last number dialed	Last number re-dial from the HF	4.15
11	Call waiting notification	Call waiting notification activation	4.16
12	Three way calling	Three way call handling	4.17
13	Calling Line Identification (CLI)	Calling Line Identification (CLI) notification	4.18
14	Echo canceling (EC) and noise reduction (NR)	HF unit requests turning off the AG's EC and NR	4.19
15	Voice recognition activation	Voice recognition activation	4.20
16	Attach a phone number to a voice tag	Attach a voice tag to a phone number	4.21
17	Ability to transmit DTMF codes	Transmit DTMF code	4.22
18	Remote audio volume control	Remote audio volume control	4.23
		Volume level synchronization	4.23

Table 3.2 Application layer feature to procedure mapping

4 Hands-Free Control Interoperability Requirements

4.1 Introduction

The interoperability requirements for the Hands-Free Control entity are completely contained in this section. Sections 4.2 through 4.23 specify the requirements for the procedures directly related to the application layer features.

The procedures listed in this section are primarily based on the use of a minimum set of AT commands as the control protocol. Section 4.24 specifies these AT commands and their result codes.

Section 4.2 specifies how Service Level Connections are handled in general and specifically states how the layers beneath the Hands-Free unit Control entity are used to establish and release a Service Level Connection.

4.2 Service Level Connection Establishment

Upon a user action or an internal event, either the HF or the AG may initiate a Service Level Connection establishment procedure.

A Service Level Connection establishment requires the existence of a RFCOMM connection, that is, a RFCOMM data link channel between the HF and the AG.

Both the HF and the AG may initiate the RFCOMM connection establishment. If there is no RFCOMM session between the AG and the HF, the initiating device shall first initialize RFCOMM.

The RFCOMM connection establishment shall be performed as described in Section 7.3 of Generic Access Profile [5] and Section 3 of Serial Port Profile [6].

4.2.1 Service Level Connection Initialization

When an RFCOMM connection has been established the Service Level Connection Initialization procedure shall be executed.

First in the initialization procedure the HF shall send the AT+BRSF=<HF supported features> command to the AG to both notify the AG of the supported features in the HF, as well as to retrieve the supported features in the AG using the +BRSF result code.

After having retrieved the supported features in the AG, the HF shall determine which indicators are supported by the AG, as well as the ordering of the supported indicators. This is because, according to the GSM 07.07 specification [2], the AG may support additional indicators not provided for by the Hands-Free Profile, and because the ordering of the indicators is implementation specific. The HF uses the AT+CIND=? Test command to retrieve information about the supported indicators and their ordering.

Once the HF has the necessary supported indicator and ordering information, it shall retrieve the current status of the indicators in the AG using the AT+CIND? Read command.

After having retrieved the status of the indicators in the AG, the HF shall then enable the "Indicators status update" function in the AG by issuing the AT+CMER command, to which the AG shall respond with OK. As a result, the AG shall send the +CIEV unsolicited result code with the corresponding indicator value whenever a change in service, call, or call setup status occurs. When an update is required for both the call and call setup indicators, the AG shall send the +CIEV unsolicited result code for the call indicator before sending the +CIEV unsolicited result code for the call setup indicator. The HF shall use the information provided by the +CIEV code to update its own internal and/or external indications.

Once the "Indicators status update" function has been enabled, the AG shall keep the function enabled until either the AT+CMER command is issued to disable it, or the current Service Level Connection between the AG and the HF is dropped for any reason.

After that the HF has enabled the "Indicators status update" function in the AG, and if the "Call waiting and 3-way calling" bit was set in the supported features bitmap by both the HF and the AG, the HF shall issue the AT+CHLD=? test command to retrieve the information about how the call hold and multiparty services are supported in the AG. The HF shall not issue the AT+CHLD=? test command in case either the HF or the AG does not support the "Three way calling" feature.

The HF shall consider the Service Level Connection to being fully initialized, and thereby established, in either of the following cases:

- After that the HF has successfully retrieved information about how call hold and multiparty services are supported in the AG using the AT+CHLD command, if and only if the "Call waiting and 3-way calling" bit was set in the supported features bitmap for both HF and AG.

- After the HF has successfully enabled the "Indicator status update" using the AT+CMER command, if and only if the "Call waiting and 3-way calling" bit was <u>not</u> set in the supported features bitmap for either the HF or the AG.

The AG shall consider the Service Level Connection to be fully initialized, and thereby established, in either of the following cases:

- After that the AG has successfully responded with information about how call hold and multiparty services are supported in the AG using +CHLD as well as responded OK, if and only if the "Call waiting and 3-way calling" bit was set in the supported features bitmap for both HF and AG.

- After the AG has successfully responded with OK to the AT+CMER command (to enable the "Indicator status update" function), if and only if the "Call waiting and 3-way calling" bit was <u>not</u> set in the supported features bitmap for either the HF or the AG.

Refer to Section 4.24 for more information on the `AT+CIND, AT+CMER, AT+CHLD and AT+BRSF` commands and the `+CIEV` unsolicited result code.
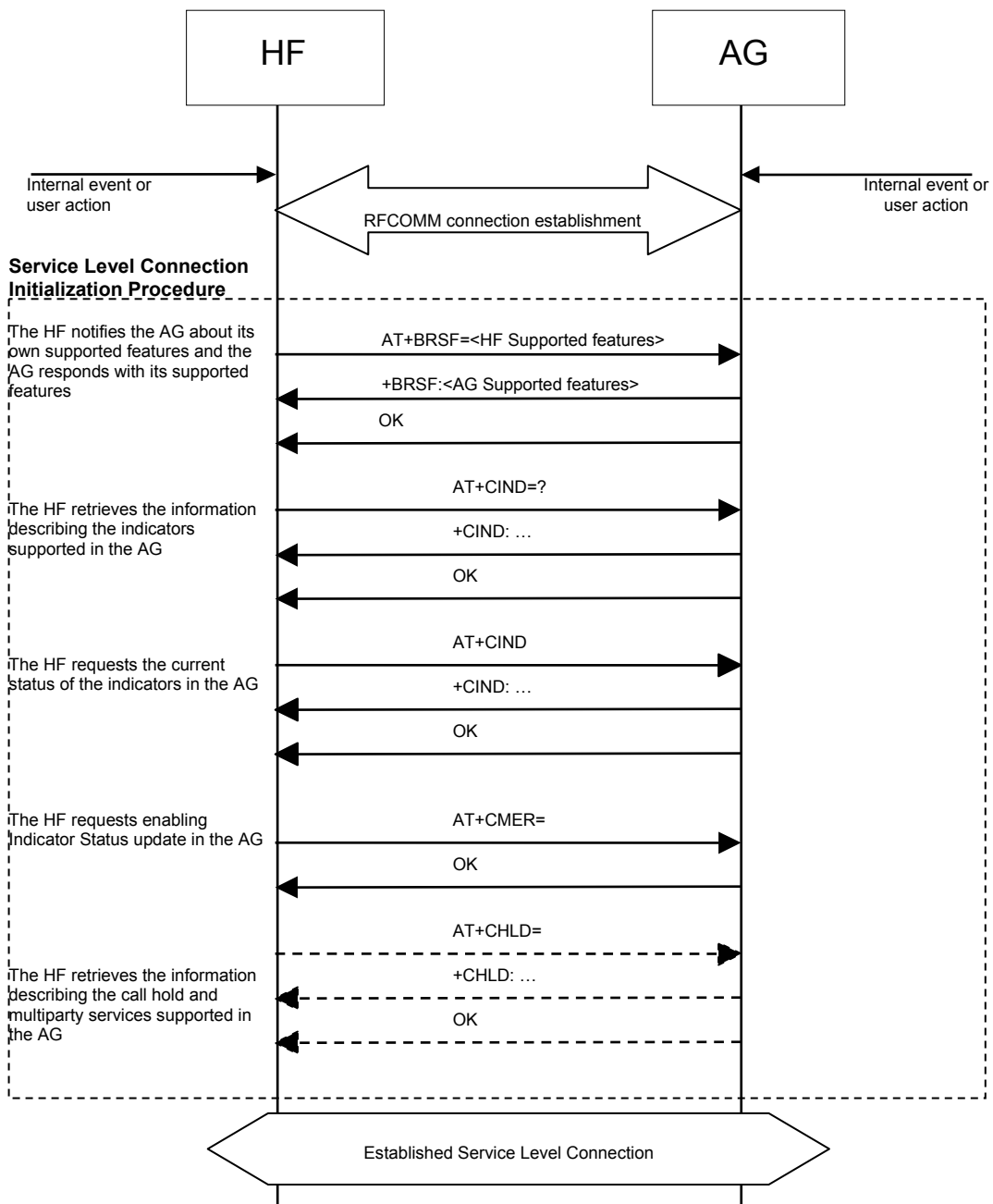
Bluetooth

Figure 4.1 Service Level Connection establishment

4.2.2 Link Loss Recovery

This section addresses the link loss recovery from a HF unit. The HF unit may reconnect with the AG whenever there is loss of Bluetooth link.

When a Service Level Connection is disconnected due to explicit termination at one end (using the "Service connection release" as described in Section 4.3), then both devices (AG and HF unit) shall wait for an explicit user action before an attempt is made to re-establish the Service Level Connection.

If the HF unit determines that the Service Level Connection was disconnected due to a link supervision timeout, then the HF unit may execute the "Service Level Connection establishment" procedure as described in Section 4.2 to establish a new Service Level Connection to the AG. Following a link loss due to link supervision timeout, the HF unit shall not assume that the service level connection state from the previous connection is valid (such as Call Status, Service Status).

4.3 Service Level Connection Release

This section describes the procedure for releasing a Service Level Connection.

The disconnection of a Service Level Connection shall immediately mean the removal of the corresponding RFCOMM data link channel between the HF and the AG. Also, an existing audio connection has to be removed as consequence of the removal of the Service Level Connection. The removal of the L2CAP and link layers is optional.

An established Service Level Connection shall be released using a "Service Level Connection removal" procedure.

- The "Service Level Connection removal" procedure shall be initiated due to an explicit user request by either the HF or AG.

- The "Service Level Connection removal" procedure shall be initiated if the Bluetooth functionality is disabled in either the HF or AG.

- The "Service Level Connection removal" procedure may be initiated if an "Audio Connection transfer towards the AG", as stated in section 4.12, is performed during an ongoing call in the AG. In the case that the Service Level Connection is removed, the AG shall attempt to re-establish the Service Level Connection once the call is dropped.

As pre-condition for this procedure, an ongoing Service Level Connection between the AG and the HF shall exist.

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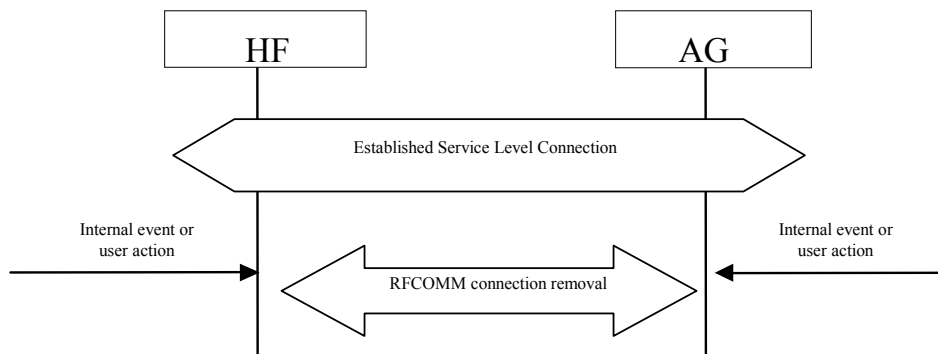
Figure 4.2 Service Level Connection removal

4.4 Transfer of Registration Status

The AT+CMER command, as described in Section 4.2, enables the
"Registration status update" function in the AG. When this function is enabled,
the AG shall send the +CIEV unsolicited result code with the corresponding
service indicator and value whenever the AG's registration status changes.
The HF unit shall be capable of interpreting the information provided by the
+CIEV result code to determine the service availability status as listed in
Section 4.24.2.

As pre-condition for this procedure, an ongoing Service Level Connection
between the AG and the HF shall exist. If this connection does not exist, the
AG shall autonomously establish the Service Level Connection using the
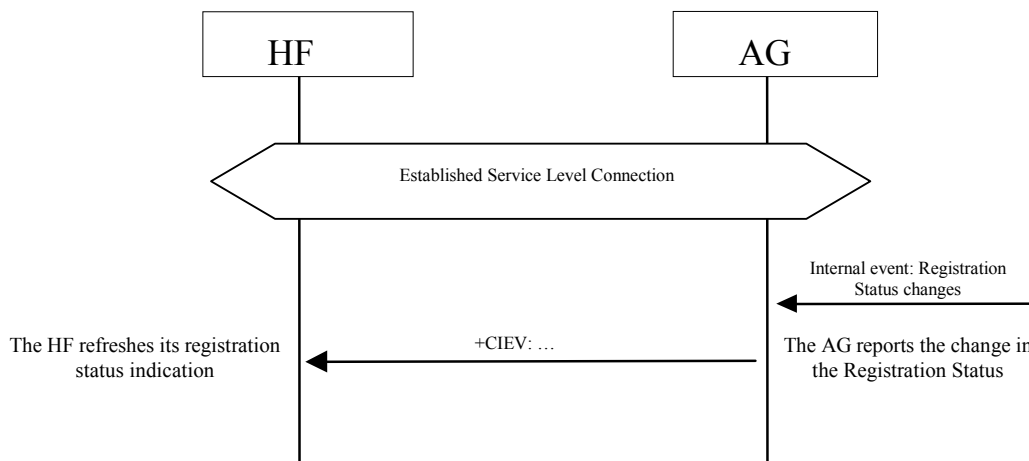proper procedure as described in Section 4.2.

Figure 4.3 Typical Registration Status update

4.5 Transfer of Call and Call Setup Status

The `AT+CMER` command, as described in Section 4.2, enables the "Call Status indicators update" function in the AG. When this function is enabled, the AG shall issue a `+CIEV` unsolicited result code with the corresponding `call` indicator and value whenever the AG's current call status changes. Likewise, the AG shall issue a `+CIEV` unsolicited result code with the corresponding `callsetup` indicator and value whenever the AG's current call setup status changes.

The HF unit shall be capable of interpreting the information provided by the `+CIEV` result code to determine the `call` status as listed in Section 4.24.2.

Furthermore, the HF unit may also be capable of interpreting the optional `callsetup` state information provided by the `+CIEV` result code as listed in Section 4.24.2.

The HF unit shall be able to accept unknown indicators provided by the `+CIEV` result code. The HF unit may ignore unknown indicators provided by the `+CIEV` result code.

Note: Although the HF unit is required to parse the `+CIEV` result codes, the HF unit is not required to provide User Interface indicators for the `+CIEV` result codes.

4.6 Audio Connection Setup

Upon a user action or an internal event, either the HF or the AG may initiate the establishment of an Audio Connection whenever necessary. Further internal actions may be needed by the HF or the AG to internally route the audio paths.

An Audio Connection set up procedure always means the establishment of a SCO link and it is always associated with an existing Service Level Connection.

In principle, setting up an Audio Connection by using the procedure described in this section is not necessarily related to any call process.

Once an Audio Connection between the HF and the AG exists, the AG shall utilize the HF as its sole audio port. The AG shall keep the audio paths, call related or not, routed towards HF for all the operations (e.g. voice, alert, key press tones) involving presence of audio.

As pre-condition for this procedure, an ongoing Service Level Connection between the AG and the HF shall exist. If this connection does not exist, the initiator of the procedure shall autonomously establish the Service Level Connection using the proper procedure as described in Section 4.2.
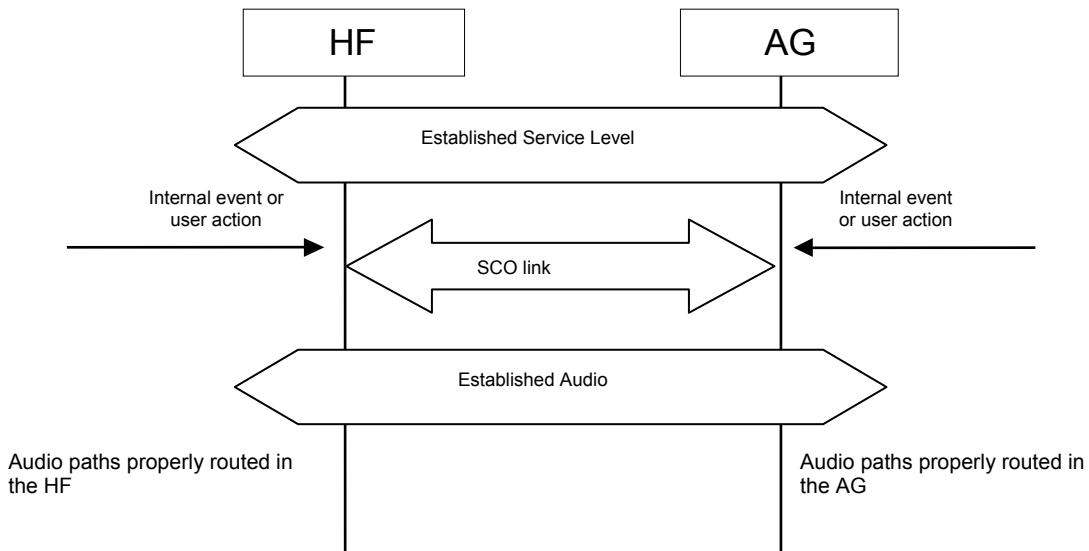
Figure 4.4 Audio Connection set up

Both the initiator and the acceptor shall notify the presence of the new Audio Connection. The incoming Audio Connection may be rejected simply by releasing it (refer to Section 4.7).

4.7 Audio Connection Release

Upon a user action or an internal event, either the HF or the AG may release an existing Audio Connection whenever necessary.

An Audio Connection removal always means the disconnection of its corresponding SCO link.

When the audio connection is released, the audio paths shall be routed to the AG.

In principle, removing an Audio Connection by using the procedure described in this section is not necessarily related to any call process.

As pre-condition for this procedure, an ongoing Audio Connection between the AG and the HF shall exist.
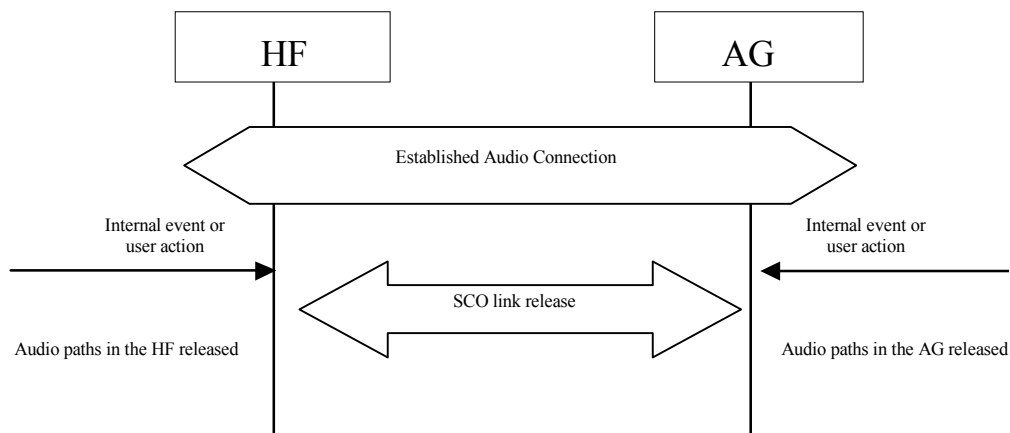
Figure 4.5 Audio Connection release

4.8 Answer an Incoming Call

Upon an incoming call, the AG shall send a sequence of unsolicited `RING` alerts to the HF. The `RING` alert shall be repeated for as long as the call acceptance is pending, or until the incoming call is interrupted for any reason.

The HF may produce a local alert (e.g. a ring tone) in reaction to the `RING`.

If the AG's SDP record indicates "In-band ringtone" is supported, the AG shall send in-band ring tones unless subsequently changed using procedures defined in Section 4.8.4.

The AG may abort the incoming call when necessary. It shall then stop sending the RING alert to the HF.

4.8.1 Answer Incoming Call from the HF – In-Band Ringing

Optionally, the AG may provide an in-band ring tone.

This case is described in Figure 4.6 below and implies, as pre-condition, that an ongoing Service Level Connection between the AG and the HF shall exist. If this connection does not exist, the AG shall autonomously establish the Service Level Connection using the proper procedure as described in Section 4.2.

As the figure below shows, if an in-band ring tone is used, the AG sends the ring tone to the HF via the established Audio Connection.

Figure 4.6 Answer an incoming call from the HF – in-band ring tone

The user accepts the incoming voice call by using the proper means provided by the HF. The HF shall then send the ATA command (see Section 4.24) to the AG. The AG shall then begin the procedure for accepting the incoming call.

If the normal incoming call procedure is interrupted for any reason, the AG shall issue the +CIEV result code, with the value indicating (callsetup=0) to notify the HF of this condition (see also Section 4.10.2).

4.8.2 Answer Incoming Call from the HF – No In-Band Ringing

As pre-condition, an ongoing Service Level Connection between the AG and the HF shall exist. If this connection does not exist, the AG shall autonomously establish the Service Level Connection using the proper procedure as described in Section 4.2.

Bluetooth

As the figure below shows, if no in-band ring tone is used and an Audio Connection does not exist, the AG shall set up the Audio Connection and route the audio paths to the HF upon answering the call.
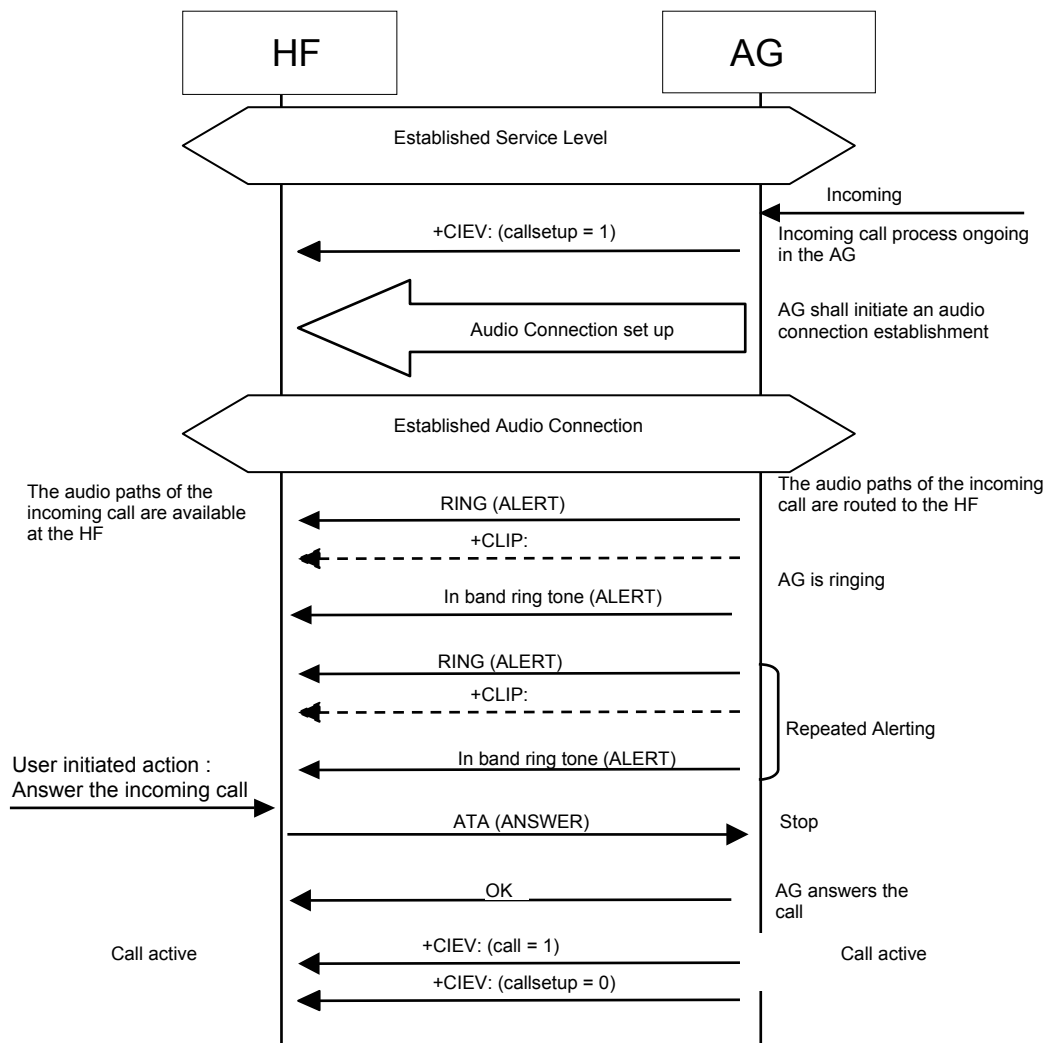

Figure 4.7 Answer an incoming call from the HF – no in-band ring tone

The user accepts the incoming voice call by using the proper means provided by the HF. The HF shall then send the `ATA` command (see Section 4.24) to the AG, and the AG shall start the procedure for accepting the incoming call and establishing the Audio Connection if an Audio Connection does not exist (refer to Section 4.6).

If the normal incoming call procedure is interrupted for any reason, the AG shall issue the `+CIEV` result code, with the value indicating `(callsetup=0)` to notify the HF of this condition (see also Section 4.10.2).

4.8.3 Answer Incoming Call from the AG

The following pre-conditions apply for this procedure:

- As pre-condition for this procedure, an ongoing Service Level Connection between the AG and the HF shall exist.

Bluetooth

- The AG shall alert the HF using either of the two procedures described in Sections 4.8.1 and 4.8.2.

- The HF shall alert the user.

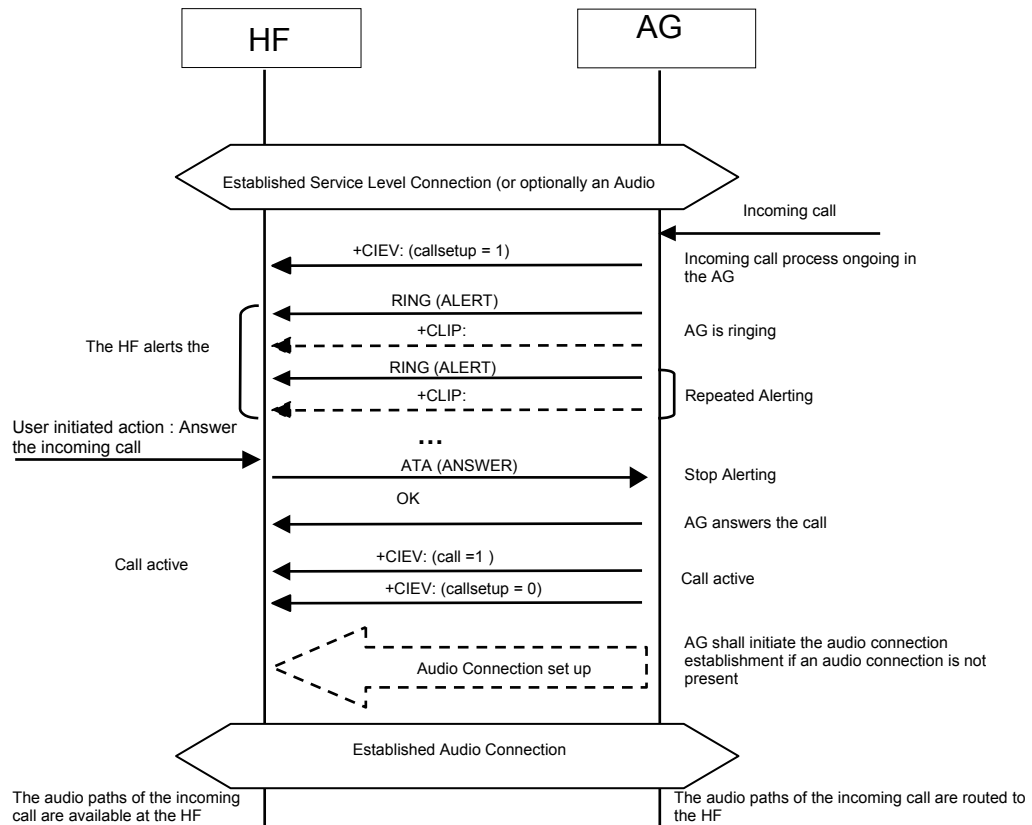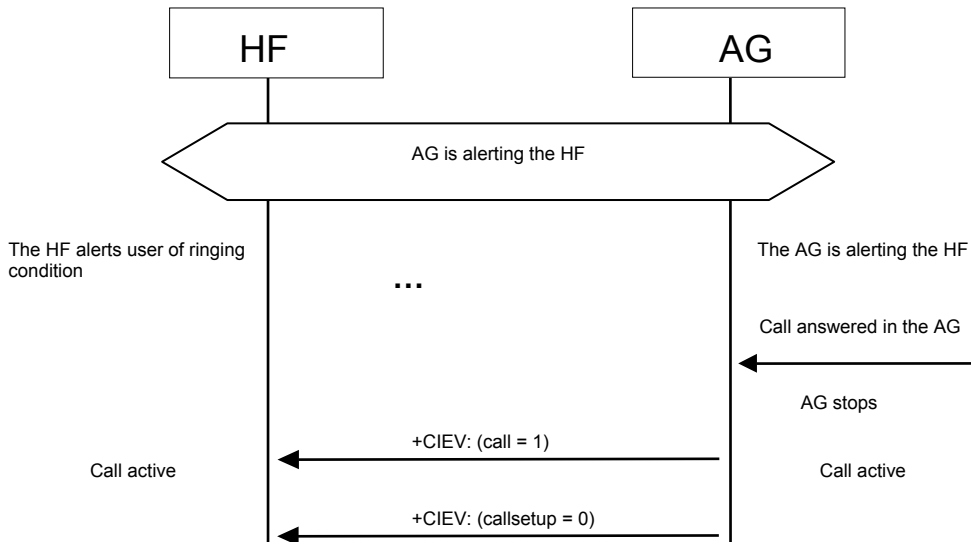*Figure 4.8 Answer an incoming call from the AG*

The user accepts the incoming call by using the proper means provided by the AG.

If the normal incoming call procedure is interrupted for any reason, the AG shall issue the `+CIEV` result code, with the value indicating `(callsetup=0)` to notify the HF of this condition (see also Section 4.10.2).

4.8.4 Change the In-Band Ring Tone Setting

The SDP record entry "In-band ring tone" of the "Supported features" record (see table 5.4) informs the HF if the AG is capable of sending an in-band ring tone or not. If the AG is capable of sending an in-band ring tone, it shall send the in-band ring tone by default. The AG may subsequently change this setting.

In case the AG wants to change the in-band ring tone setting during an ongoing service level connection, it shall use the unsolicited result code `+BSIR` (Bluetooth Set In-band Ring tone) to notify the HF about the change. See Figure 4.9 for details.

Refer to Section 4.24 for more information on the `+BSIR` unsolicited result code.

Bluetooth

The in-band ring tone setting may be changed several times during a Service Level Connection.

As pre-condition for this procedure, an ongoing Service Level Connection between the AG and the HF shall exist. If this connection does not exist, the AG shall autonomously establish the Service Level Connection using the proper procedure as described in Section 4.2.
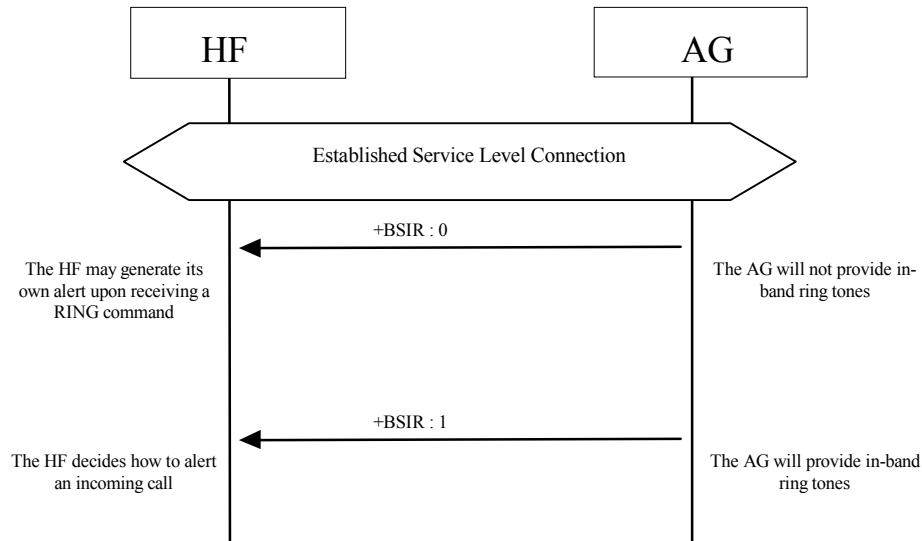
Figure 4.9:Change of the in-band ring tone setting initiated by the AG

In case the HF does not want to use the AG's in-band ring tone, it may mute the SCO link after it has received `+CIEV:(callsetup=1)`. The HF shall un-mute the SCO link upon receiving the `+CIEV:(callsetup=0)` indication.

4.9 Reject an Incoming Call

In case of an incoming call, the AG shall alert the HF by either one of the two procedures described in Sections 4.8.1 and 4.8.2.

Instead of answering the call, the user may reject the incoming call process by user action at the HF or the AG. These two procedures are described in the following sections.

4.9.1 Reject an Incoming Call from the HF

As a precondition to this procedure, the AG shall alert the HF using either of the two procedures described in Sections 4.8.1 and 4.8.2.

The user rejects the incoming call by using the User Interface on the Hands-Free unit. The HF shall then send the `AT+CHUP` command (see Section 4.24) to the AG. This may happen at any time during the procedures described in Sections 4.8.1 and 4.8.2.

The AG shall then reject the incoming call and send the `OK` indication followed by the `+CIEV` result code, with the value indicating `(callsetup=0)`.
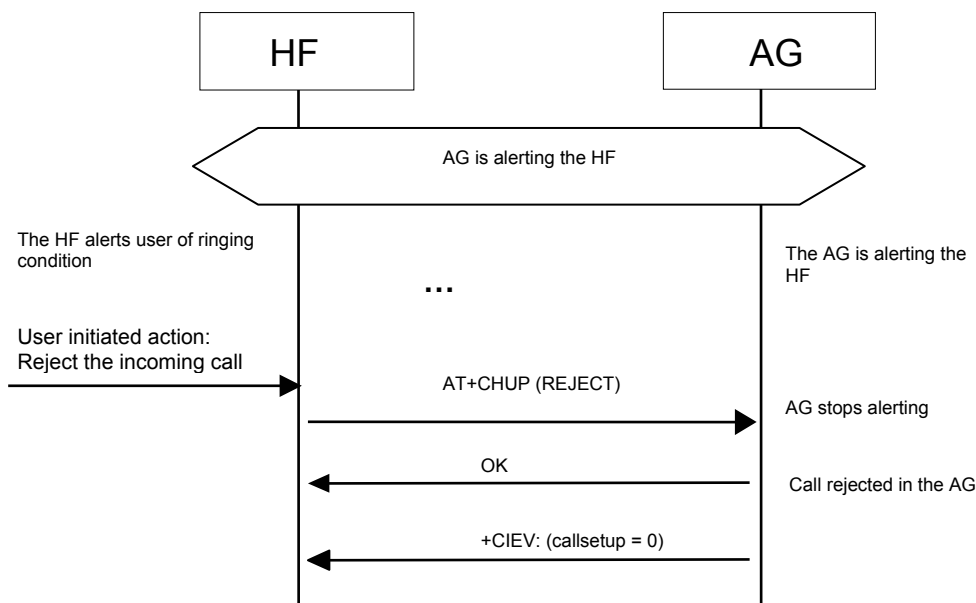
Figure 4.10 Reject an incoming call from the HF

4.9.2   Rejection/Interruption of an Incoming Call in the AG

As a precondition to this procedure, the AG shall alert the HF using either of the two procedures described in Sections 4.8.1 and 4.8.2.

The user rejects the incoming call by using the User Interface on the AG. Alternatively the incoming call process may be interrupted in the AG for any other reason.

As consequence of this, the AG shall send the `+CIEV` result code, with the value indicating `(callsetup=0)`. The HF shall then stop alerting the user.

This may happen at any time during the procedures described in Sections 4.8.1 and 4.8.2.
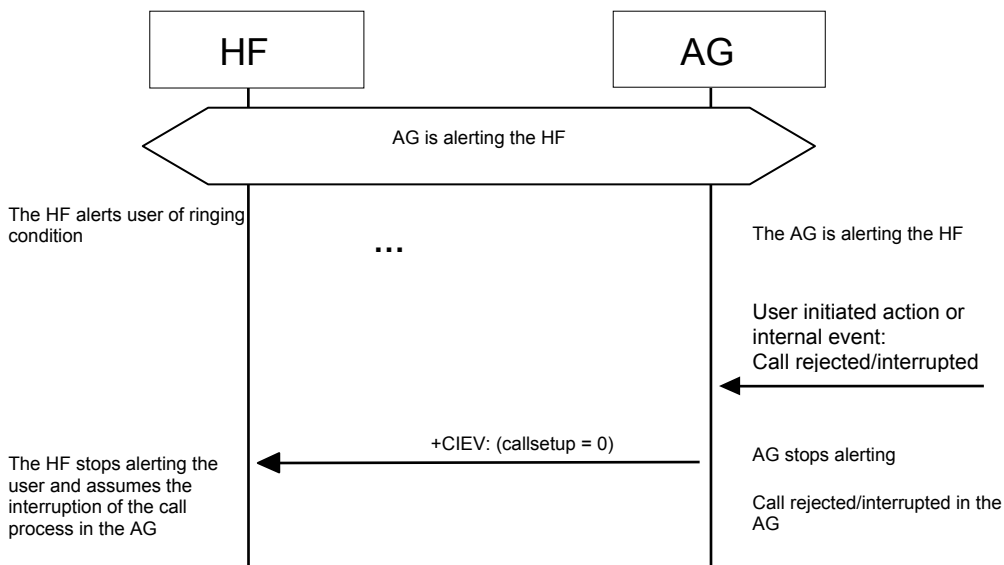
Figure 4.11 Rejection/interruption of an incoming call in the AG

4.10 Terminate a Call Process

An ongoing call procedure may be terminated by either the HF or the AG by means of a user action or any other event.

4.10.1 Terminate a Call Process from the HF

The following pre-conditions apply for this procedure:

- An ongoing Service Level Connection between the AG and the HF shall exist. If this connection does not exist, the HF shall autonomously establish the Service Level Connection using the proper procedure as described in Section 4.2.

- A call related process is ongoing in the AG.

Although not required for the call termination process, an Audio Connection is typically present between the HF and AG.

Bluetooth
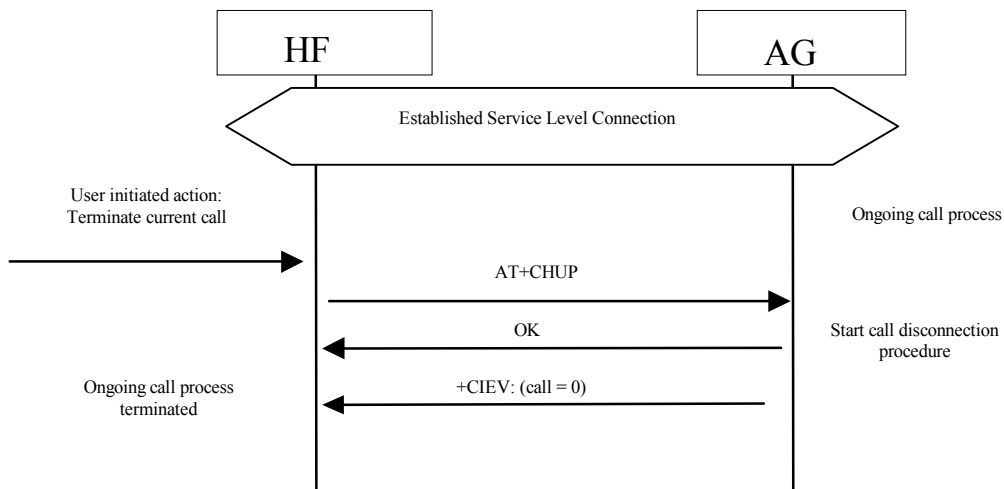
Figure 4.12 Terminate ongoing call - HF initiated

The user may abort the ongoing call process using whatever means provided by the Hands-Free unit. The HF shall send AT+CHUP command (see Section 4.24) to the AG, and the AG shall then start the procedure to terminate or interrupt the current call procedure. The AG shall then send the OK indication followed by the +CIEV result code, with the value indicating (call=0).

Performing a similar procedure, the AT+CHUP command described above may also be used for interrupting a normal outgoing call set-up process.

Although not required for the call termination process, an Audio Connection is typically present between the HF and AG.

4.10.2 Terminate a Call Process from the AG

The following pre-conditions apply for this procedure:

• An ongoing Service Level Connection between the AG and the HF shall exist. If this connection does not exist, the AG shall autonomously establish the Service Level Connection using the proper procedure as described in Section 4.2.

• A call related process is ongoing in the AG.

Bluetooth

Figure 4.13 Terminate ongoing call - AG initiated

This procedure is fully applicable for cases in which an ongoing call process is interrupted in the AG for any reason.

In this case the AG shall send the `+CIEV` result code, with the value indicating (`call=0`).

4.11 Audio Connection Transfer Towards the HF

The audio paths of an ongoing call may be transferred from the AG to the HF. This procedure represents a particular case of an "Audio Connection set up" procedure, as described in Section 4.6.

The call connection transfer from the AG to the HF is initiated by a user action either on the HF or on the AG side. This shall result in either the HF or the AG, respectively, initiating an "Audio Connection set up" procedure with the audio paths of the current call being routed to the HF.

This procedure is only applicable if there is no current Audio Connection established between the HF and the AG. In fact, if the Audio Connection already exists, this procedure is not necessary because the audio paths of the AG are assumed to be already routed towards the HF.

The following pre-conditions apply for this procedure:

- An ongoing Service Level Connection between the AG and the HF shall exist. If this connection does not exist, the initiator of the "Audio Connection transfer towards the HF" procedure shall autonomously establish the Service Level Connection using the proper procedure as described in Section 4.2.
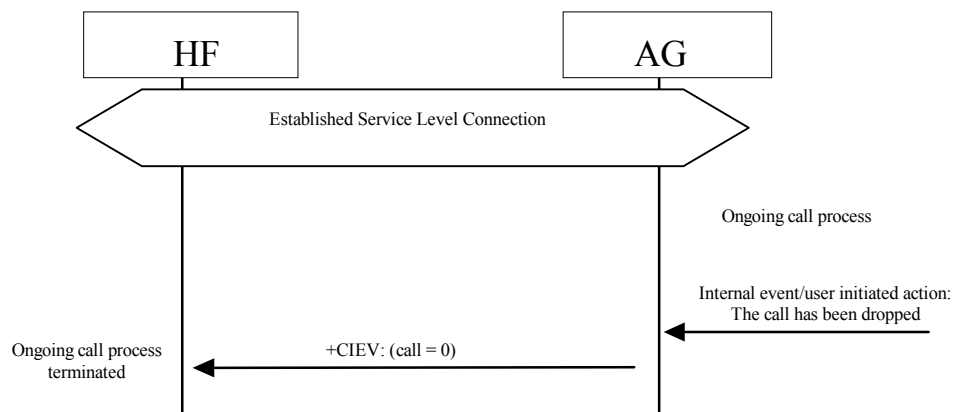
- An ongoing call process exists in the AG, with the audio paths routed to the AG means.

Bluetooth
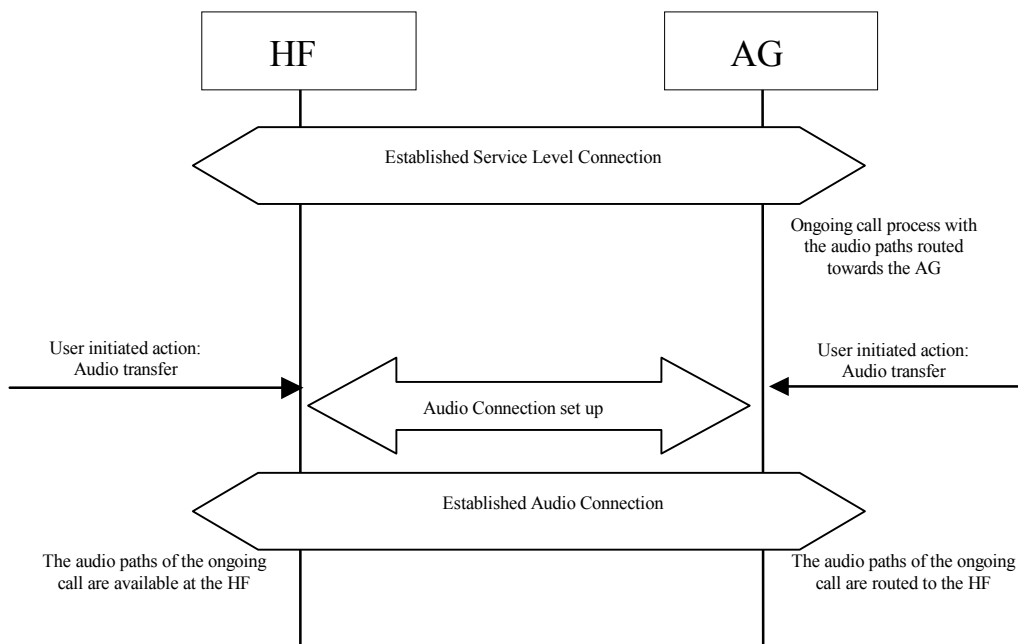
Figure 4.14 Audio Connection transfer to the HF

4.12 Audio Connection Transfer Towards the AG

The audio paths of an ongoing call may be transferred from the HF to the AG. This procedure represents a particular case of an "Audio Connection release" procedure, as described in Section 4.7.

The call connection transfer from the HF to the AG is initiated by a user action in the HF or due to an internal event or user action in the AG side. This results in an "Audio Connection release" procedure being initiated either by the HF or the AG respectively, with the current call kept and its audio paths routed to the AG.

If as a consequence of an HF initiated "Audio Connection transfer towards the AG" procedure, the existing Service Level Connection is autonomously removed, the AG shall attempt to re-establish the Service Level Connection once the current call ends.

As pre-condition for this procedure, an ongoing call process shall exist in the AG. The audio paths of the ongoing call shall be available in the HF via an Audio Connection established between the AG and the HF.
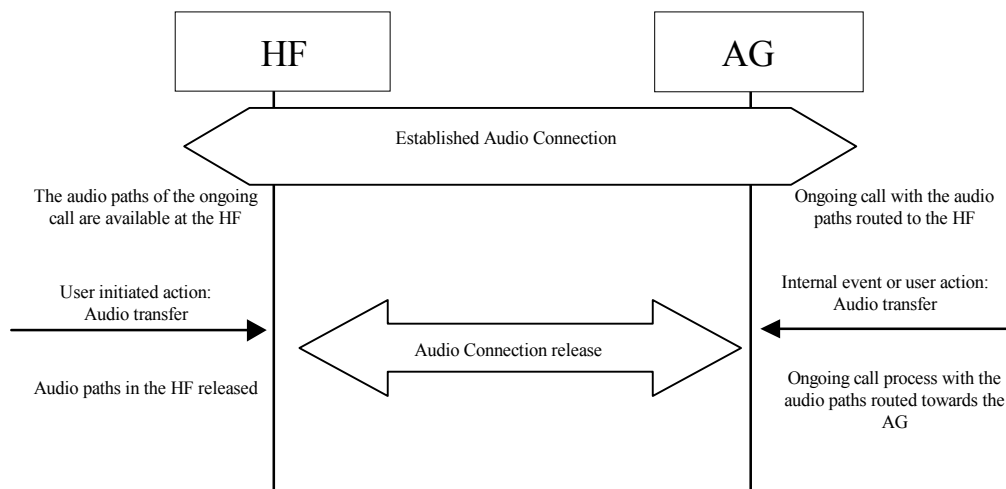
Figure 4.15 Audio Connection transfer to the AG

4.13 Place a Call With the Phone Number Supplied by the HF

The HF may initiate outgoing voice calls by providing the destination phone number to the AG. To start the call set-up, the HF shall initiate the Service Level Connection establishment (if necessary) and send a proper `ATDdd…dd;` command to the AG. The AG shall then start the call establishment procedure using the phone number received from the HF and issues the `+CIEV` result code, with the value `(callsetup=2)` to notify the HF that the call set-up has been successfully initiated.

Refer to Section 4.24 for more information on the `ATDdd…dd;` command.

As pre-condition for this procedure, an ongoing Service Level Connection between the AG and the HF shall exist. If this connection does not exist, the HF shall autonomously establish the Service Level Connection using the proper procedure as described in Section 4.2.

If an Audio Connection is not established the AG shall establish the proper Audio Connection and route the audio paths of the outgoing call to the HF immediately following the commencement of the ongoing call set up procedure.

Once alerting of the remote party begins, the AG shall issue the `+CIEV` result code, with the value indicating `(callsetup=3)`.

If the normal outgoing call establishment procedure is interrupted for any reason, the AG shall issue the `+CIEV` result code, with the value indicating `(callsetup=0)`, to notify the HF of this condition (see Section 4.10.2).

If the AG supports the "Three-way calling" feature and if a call is already ongoing in the AG, performing this procedure shall result in a new call being

Bluetooth

placed to a third party with the current ongoing call put on hold. For details on how to handle multiparty calls refer to Section 4.17.2.

Figure 4.16 Place an outgoing voice call with the digits entered in the HF

4.14 Memory Dialing from the HF

The HF may initiate outgoing voice calls using the memory dialing feature of the AG. To start the call set-up, the HF shall initiate the Service Level Connection establishment (if necessary) and send an `ATD>nnn;` command to the AG. The AG shall then start the call establishment procedure using the phone number stored in the AG memory location given by `nnn,` and issue the `+CIEV` result code, with the value `(callsetup=2)` to notify the HF that the call set-up has been successfully initiated.

Refer to Section 4.24 for more information on the `ATD>nnn` command.

As pre-condition for this procedure, an ongoing Service Level Connection between the AG and the HF shall exist. If this connection does not exist, the HF shall autonomously establish the Service Level Connection using the proper procedure as described in Section 4.2.

If an Audio Connection is not established, the AG shall establish the proper Audio Connection and route the audio paths of the outgoing call to the HF

Bluetooth

immediately following the commencement of the ongoing call set up procedure.

Once alerting of the remote party begins, the AG shall issue the `+CIEV` result code, with the value indicating `(callsetup=3)`.

If the normal outgoing call establishment procedure is interrupted for any reason, the AG shall issue the `+CIEV` result code, with the value indicating `(callsetup=0)`, to notify the HF of this condition (see Section 4.10.2).

If the AG supports the "Three-way calling" feature and if a call is already ongoing in the AG, performing this procedure shall result in a new call being placed to a third party with the current ongoing call put on hold. For details on how to handle multiparty calls refer to Section 4.17.2.
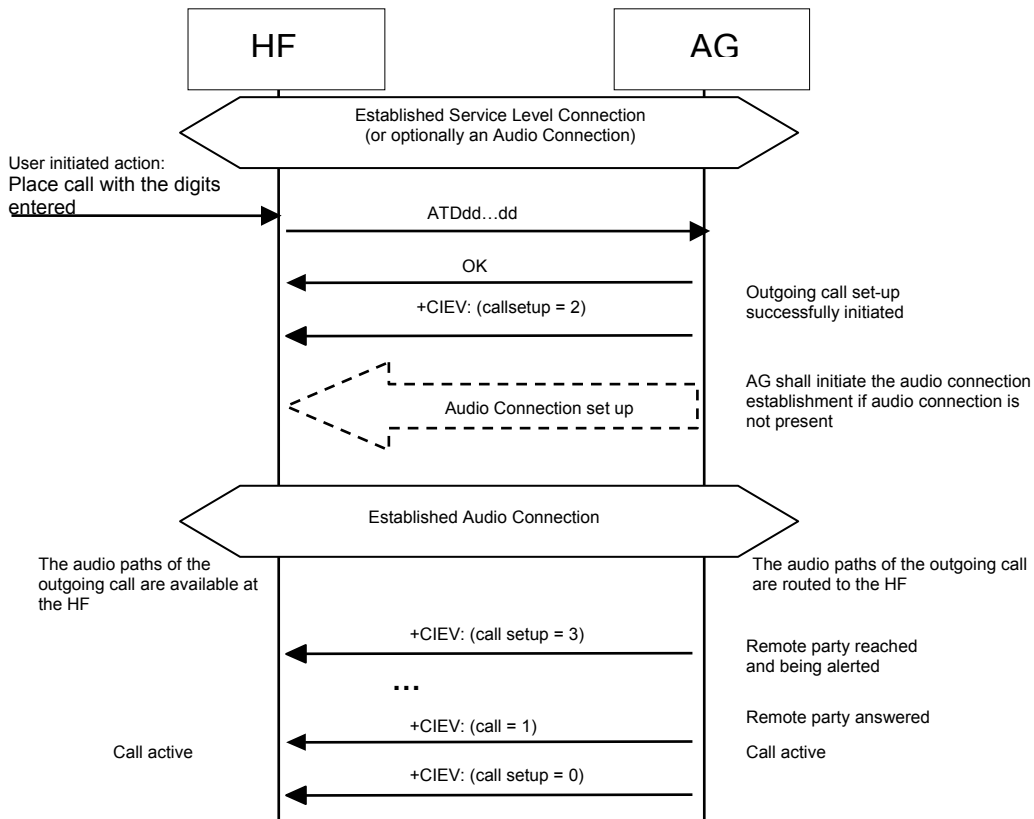

Figure 4.17 Place an outgoing voice call using memory dialing

Bluetooth

4.15 Last Number Re-Dial from the HF

The HF may initiate outgoing voice calls by recalling the last number dialed by the AG. To start the call set-up, the HF shall initiate the Service Level Connection establishment (if necessary) and send an AT+BLDN command to the AG. The AG shall then start the call establishment procedure using the last phone number dialed by the AG, and issues the +CIEV result code, with the value (callsetup=2), to notify the HF that the call set-up has been successfully initiated.

Refer to Section 4.24 for more information on the AT+BLDN command.

As pre-condition for this procedure, an ongoing Service Level Connection between the AG and the HF shall exist. If this connection does not exist, the HF shall autonomously establish the Service Level Connection using the proper procedure as described in Section 4.2.

If an Audio Connection is not established, the AG shall establish the proper Audio Connection and route the audio paths of the outgoing call to the HF immediately following the commencement of the ongoing call set up procedure.

Once alerting of the remote party begins, the AG shall issue the +CIEV result code, with the value indicating (callsetup=3).

If the normal outgoing call establishment procedure is interrupted for any reason, the AG shall issue the +CIEV result code, with the value indicating (callsetup=0), to notify the HF of this condition (see Section 4.10.2).

If the AG supports the "Three-way calling" feature and if a call is already ongoing in the AG, performing this procedure shall result in a new call being placed to a third party with the current ongoing call put on hold. For details on how to handle multiparty calls refer to Section 4.17.2.
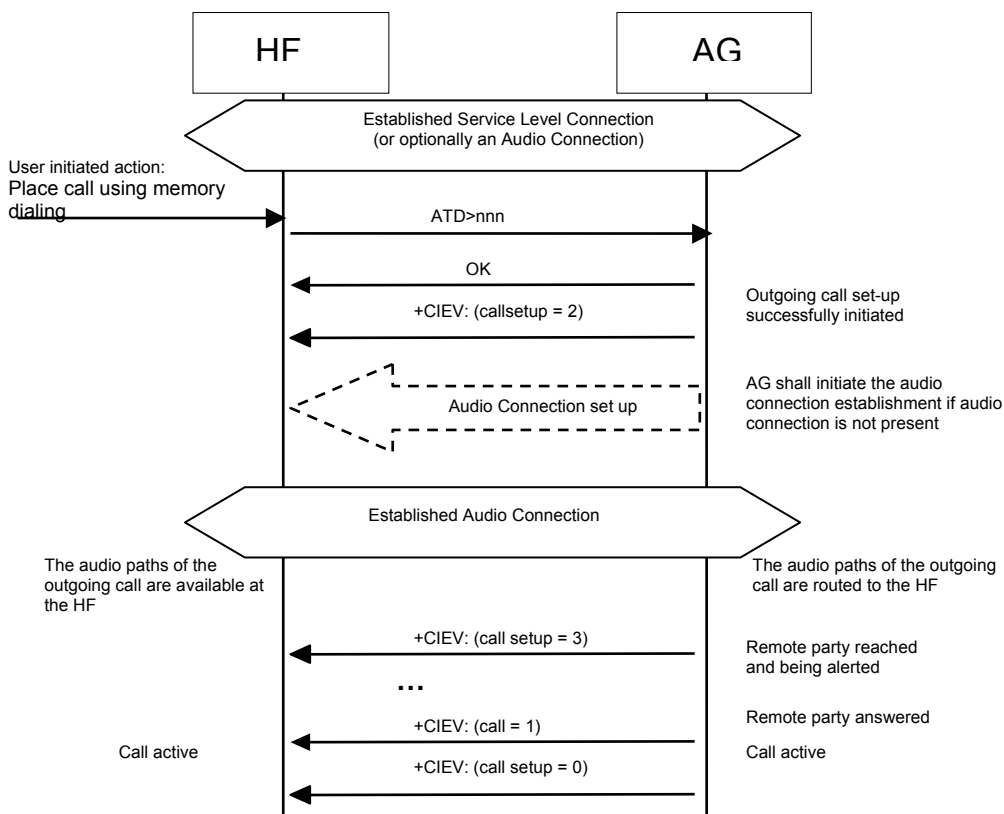
Figure 4.18 Place an outgoing voice call with the last number dialed

4.16 Call Waiting Notification Activation

The HF may issue the AT+CCWA command to enable the "Call Waiting notification" function in the AG. Once the "Call Waiting notification" is enabled, the AG shall send the corresponding +CCWA unsolicited result code to the HF whenever an incoming call is waiting during an ongoing call. It is always assumed that the "call waiting" service is already active in the network.

Once the HF issues the AT+CCWA command, the AG shall respond with OK. It shall then keep the "Call Waiting notification" enabled until either the AT+CCWA command is issued to disable "Call Waiting notification," or the current Service Level Connection between the AG and the HF is dropped for any reason.

Refer to Section 4.24 for more information on the AT+CCWA command.

Support for this call waiting notification feature implies support for the corresponding means to handle the waiting call itself. See Section 4.17 below for more details.

As pre-condition for this procedure, an ongoing Service Level Connection between the AG and the HF shall exist. If this connection does not exist, the HF shall autonomously establish the Service Level Connection using the proper procedure as described in Section 4.2.

Bluetooth
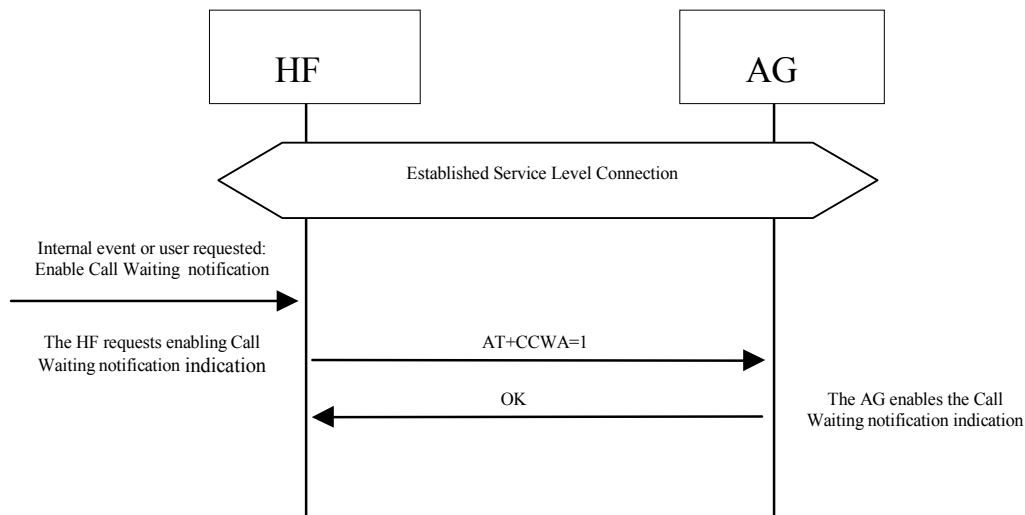
Figure 4.19 Activation of Call Waiting notification

4.17 Three Way Call Handling

Proper management of several concurrent calls shall be accomplished by performing the procedures described in [2] but with some limitations stated in this specification. For more details, refer to Section 4.24.

It is always assumed that the "call hold and/or multiparty" services are available in the network.

In general, when the user deals with multiple concurrent calls, the HF shall issue the corresponding AT+CHLD command as a result of user actions. This command allows the control of multiple concurrent calls and provides means for holding calls, releasing calls, switching between two calls, and adding a call to a multiparty conference.

When this feature is supported, the HF is only mandated to implement the "basic Three Way calling" commands AT+CHLD = 0, 1, 2 and 3.

This section covers two cases. In one case the third party call is received in the AG, and notification is sent to the HF via a Call Waiting notification. In the second case, the third party call is placed from the HF.

Refer to Section 4.24 for more information on the AT+CHLD command.

The following pre-conditions apply for these procedures:

• As pre-condition for this procedure, an ongoing Service Level Connection between the AG and the HF shall exist. If this connection does not exist, the initiator of the procedure shall autonomously establish the Service Level Connection using the proper procedure as described in Section 4.2.

Bluetooth

- An ongoing call in the AG shall exist.

4.17.1 Three Way Calling - Call Waiting Notification

In addition to the two previously stated preconditions, the Call Waiting notification to the HF shall already be enabled in the AG (that is, the procedure stated in Section 4.16 has been performed).
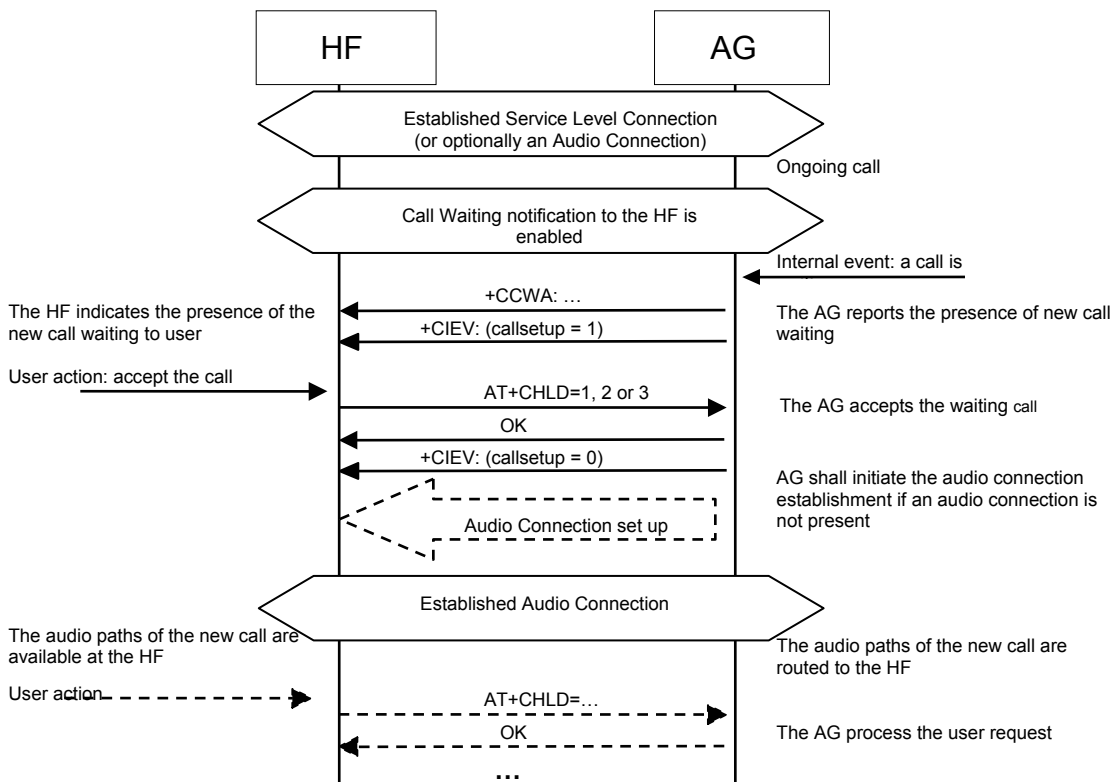
Figure 4.20 Typical Call Waiting indication followed by a three way call set up process

If the AG receives a third party call, it shall send the call waiting notification `+CCWA` and `+CIEV` result code, with the value indicating `(callsetup=1)`, to the HF. If the user accepts the call at the HF, it shall send the `AT+CHLD` with parameter 1, 2 or 3 to the AG. The AG shall then accept the waiting call and respond with `OK`, and issue the `+CIEV` result code with the value indicating `(callsetup=0)`.

Optionally, the HF may then use the `AT+CHLD` command, in order to change the status of the held and active calls.

If the normal incoming call procedure is interrupted for any reason, the AG shall issue the `+CIEV` result code, with the value indicating `(callsetup=0)`, to notify the HF of this condition (see Section 4.10.2).

Bluetooth

4.17.2 Three Way Calls – Third Party Call Placed from the HF
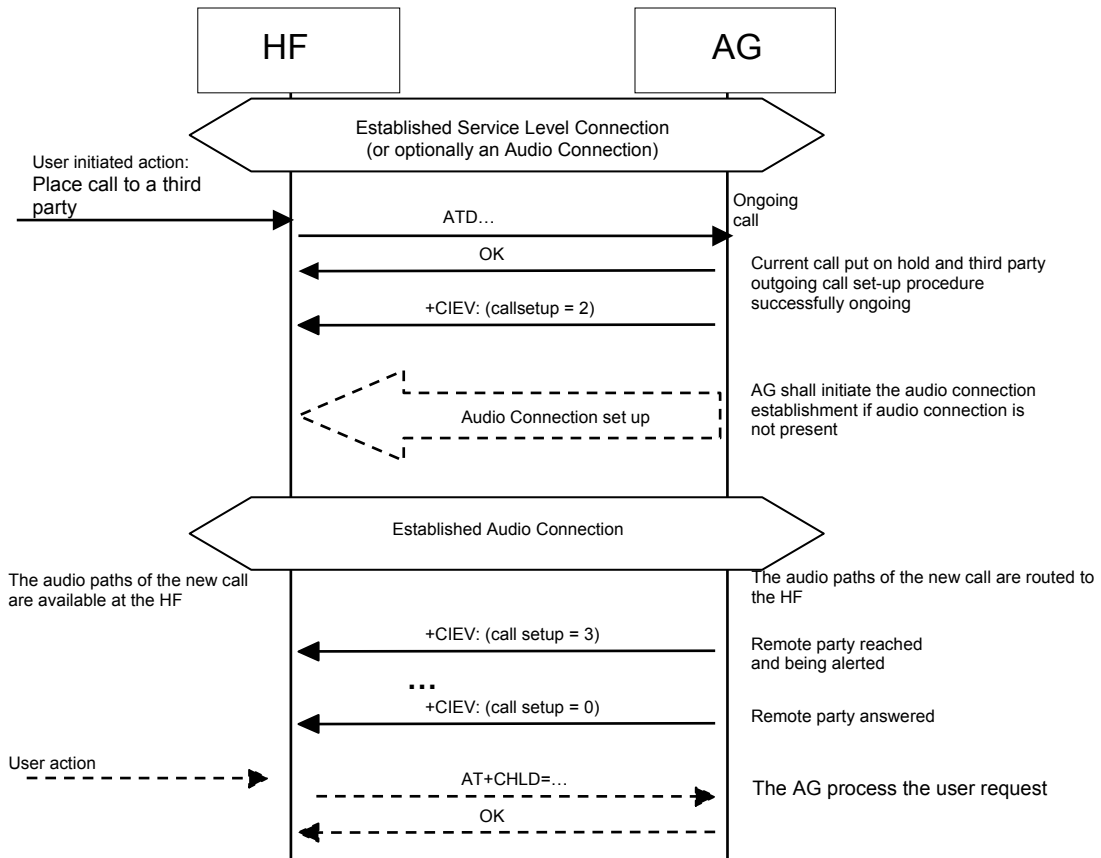
Figure 4.21 Three way call handling when the third party call is placed from the HF

If a third party call is placed from the HF using the ATD command, the AG shall send the OK indication and +CIEV result code, with the value indicating (callsetup=2), to the HF. If the remote party is reached and alerted, the AG shall issue the +CIEV result code with the value indicating (callsetup=3). If afterwards, the remote party answers the call, the AG shall issue the +CIEV result code with the value indicating (callsetup=0).

Optionally, the HF may then use the AT+CHLD command, in order to change the status of the held and active calls.

If the normal incoming call procedure is interrupted for any reason, the AG shall issue the +CIEV result code, with the value indicating (callsetup=0), to notify the HF of this condition (see Section 4.10.2).

4.18 Calling Line Identification (CLI) Notification

The HF may issue the AT+CLIP command to enable the "Calling Line Identification notification" function in the AG.

Bluetooth

If the calling subscriber number information is available from the network, the AG shall issue the `+CLIP` unsolicited result code just after every `RING` indication when the HF is alerted in an incoming call. See Section 4.8 for more details.

Once the HF issues the `AT+CLIP` command, the AG shall respond with `OK`. The AG shall then keep the "Calling Line Identification notification" enabled until either the `AT+CLIP` command is issued by the HF to disable it, or the current Service Level Connection between the AG and the HF is dropped for any reason.

Refer to Section 4.24 for more information on the `AT+CLIP` command.

As pre-condition for this procedure, an ongoing Service Level Connection between the AG and the HF shall exist. If this connection does not exist, the HF shall autonomously establish the Service Level Connection using the proper procedure as described in Section 4.2.
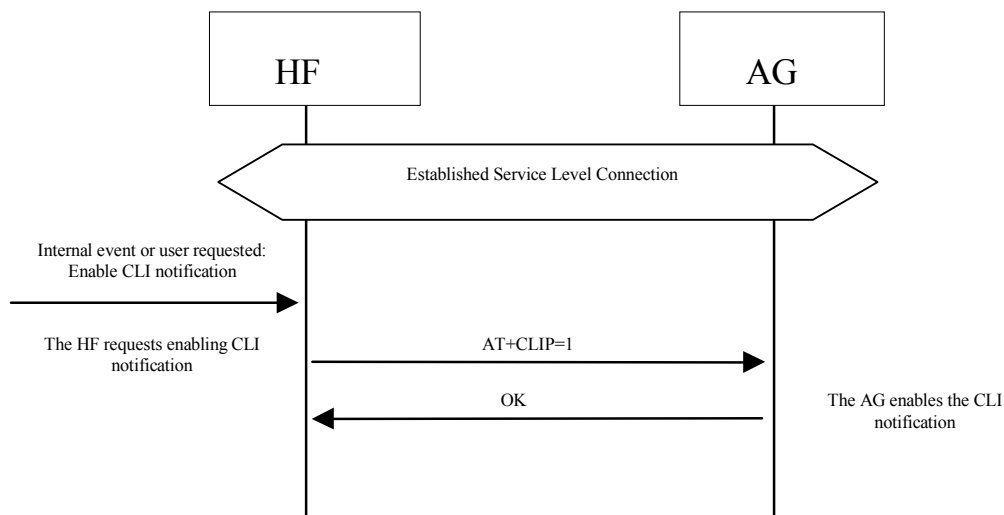
Figure 4.22 Activation of CLI notification

4.19 The HF Requests Turning Off the AG's EC and NR

The HF may disable the echo canceling and noise reduction functions resident in the AG via the `AT+NREC` command.

If the HF supports embedded EC and/or NR functions it shall support the `AT+NREC` command as described in the procedures in this section. Moreover, if the HF has these functions enabled, it shall perform this procedure before any Audio Connection between the HF and the AG is established.

By default, if the AG supports its own embedded echo canceling and/or noise reduction functions, it shall have them activated until the `AT+NREC` command

Bluetooth

is received. From then on, and until the current Service Level Connection between the AG and HF is dropped for any reason, the AG shall disable these functions every time an Audio Connection between the HF and the AG is used for audio routing.

If the AG does not support any echo canceling and noise reduction functions, it shall respond with the ERROR indicator on reception of the AT+NREC command.

Refer to Section 4.24 for more information on the AT+NREC command.

As pre-condition for this procedure, an ongoing Service Level Connection between the AG and the HF shall exist. If this connection does not exist, the HF shall autonomously establish the Service Level Connection using the proper procedure as described in Section 4.2.


Figure 4.23 NR and EC functions available in the AG

The HF sends the AT+NREC command and AG confirms with either OK or ERROR indication.

4.20 Voice Recognition Activation

The HF, via the AT+BVRA command, or the AG autonomously, may activate/deactivate the voice recognition function resident in the AG. Beyond the audio routing and voice recognition activation capabilities, the rest of the voice recognition functionality is implementation dependent.

Whenever the AG supports a voice recognition function it shall support the AT+BVRA command as described in the procedures in this section.

If the HF issues the AT+BVRA command, the AG shall respond with the OK result code if it supports voice recognition, then initiate an Audio Connection

establishment with the HF (if the Audio Connection does not already exist) and begin the voice input sequence.

If the AG does not support voice recognition, the AG shall respond with the ERROR indication.

When the voice recognition function is activated from the AG, it shall inform the HF via the +BVRA: 1 unsolicited result code and the AG shall initiate an Audio Connection establishment with the HF (if the Audio Connection does not already exist) and begin the voice input sequence.

Once activated, depending upon the voice recognition implementation, the AG shall then keep the voice recognition function enabled:

- For the duration of time supported by the implementation ("momentary on" voice recognition implementation). In this case, the AG shall notify the HF by sending a +BVRA: 0 unsolicited result code.

- Or until the AT+BVRA command is issued to disable voice recognition from the HF.

- Or until the current Service Level Connection between the AG and the HF is dropped for any reason.

Refer to Section 4.24 for more information on the AT+BVRA command and the +BVRA result code.

As pre-condition for these procedures, an ongoing Service Level Connection between the AG and the HF shall exist. If this connection does not exist, the initiator of the procedure shall autonomously establish the Service Level Connection using the proper procedure as described in Section 4.2.

Bluetooth

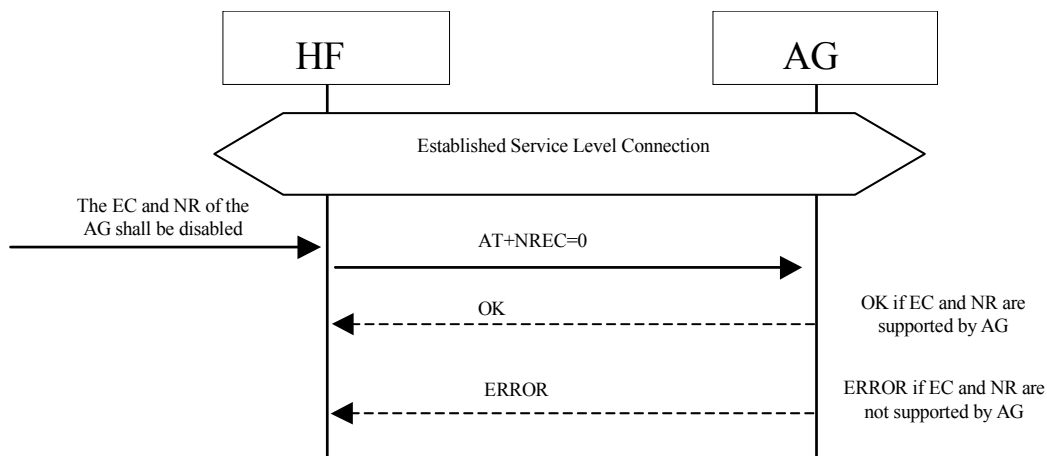## 4.20.1 Voice Recognition Activation – HF Initiated
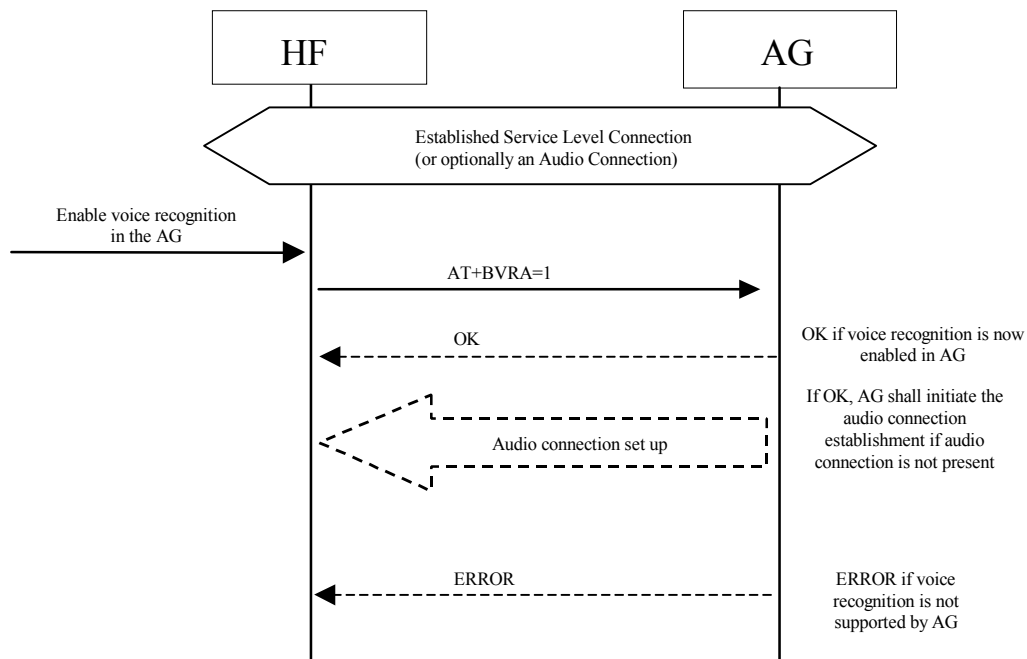
Figure 4.24 Voice recognition activation – HF initiated

4.20.2 Voice Recognition Activation – AG Initiated
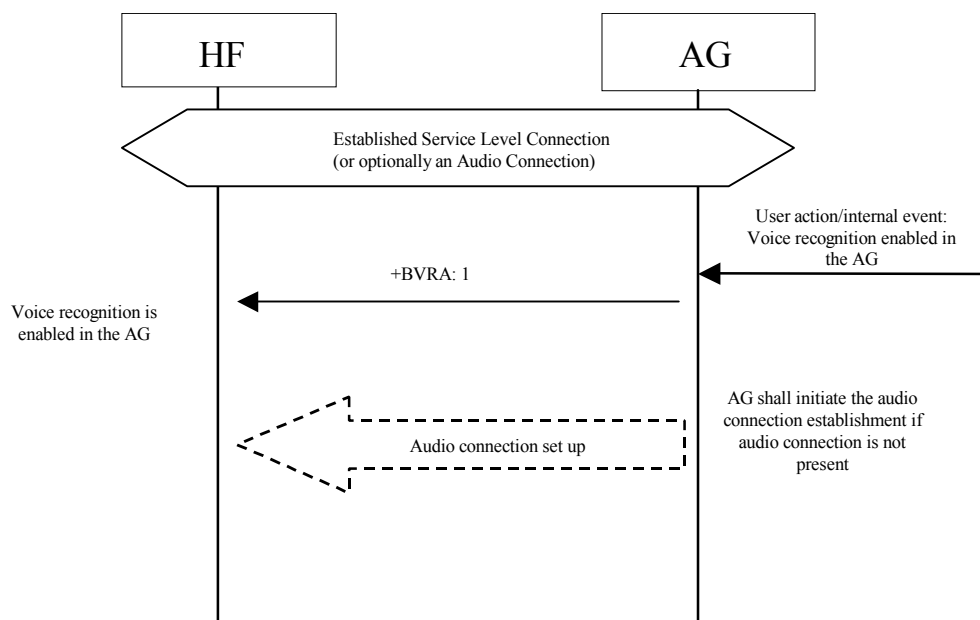
Figure 4.25 Voice recognition activation – AG initiated

4.20.3 Voice Recognition Deactivation
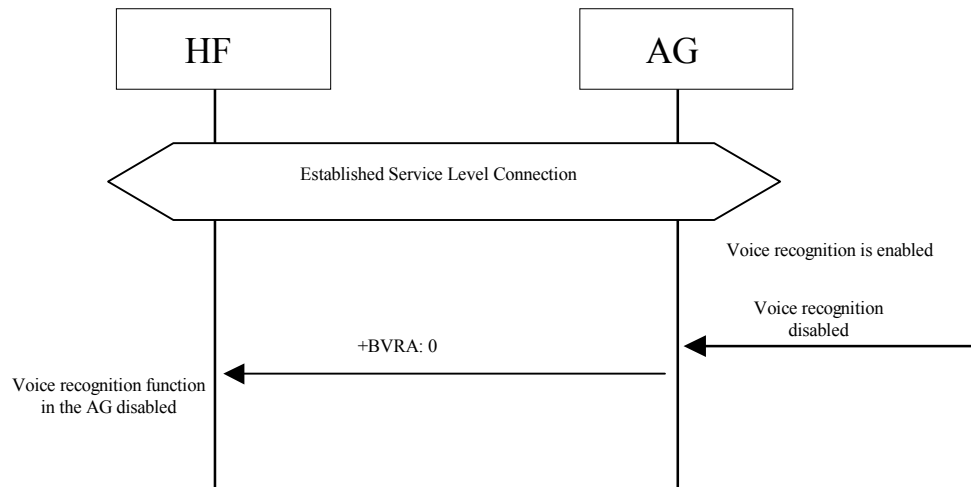
Figure 4.26 Voice recognition deactivation – "momentary on" approach
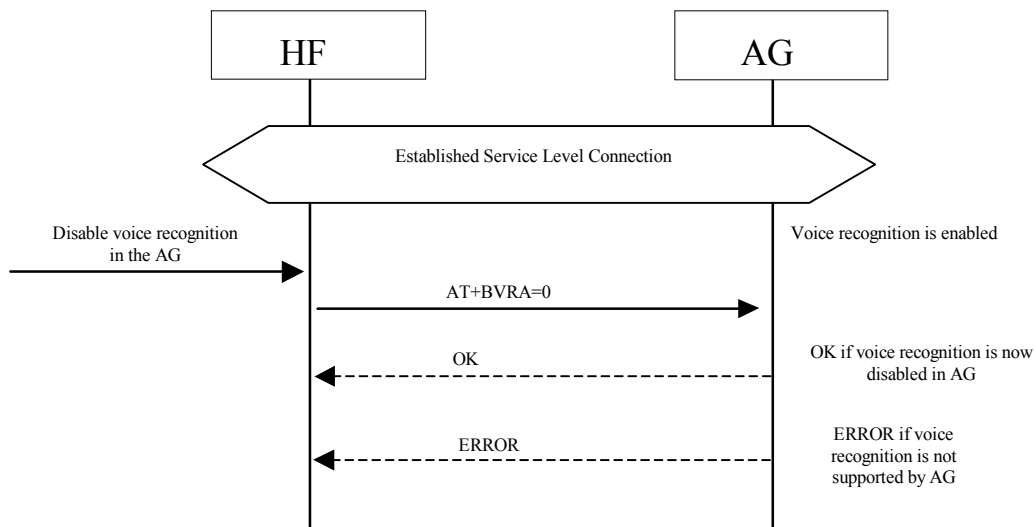
Figure 4.27 Voice recognition deactivation from the HF

4.21 Attach a Phone Number to a Voice Tag

This procedure is applicable to HF units supporting internal voice recognition functionality. It provides a means to read numbers from the AG for the purpose of creating a unique voice tag and storing the number and its linked voice tag in the HF unit's memory. The HF unit may then use its internal Voice Recognition to dial the linked phone numbers when a voice tag is recognized by using the procedure "Place a call with the phone number supplied by the HF" described in Section 4.13.

Upon an internal event or user action, the HF may request a phone number from the AG by issuing the `AT+BINP=1` command. Depending on the current status of the AG, it may either accept or reject this request.

If the AG accepts the request, it shall obtain a phone number and send the phone number back to the HF by issuing the `+BINP` response.

If the AG rejects the request from the HF, it shall issue the `ERROR` result code to indicate this circumstance to the HF.

When this procedure is executed multiple times (to retrieve multiple AG phone numbers to be linked to voice tags), it is the responsibility of the AG to provide the next phone number to be passed to the HF each time the procedure is executed.

Refer to Section 4.24 for more information on the `AT+BINP` command and the `+BINP` response.

As pre-condition for this procedure, an ongoing Service Level Connection between the AG and the HF shall exist. If this connection does not exist, the HF shall autonomously establish the Service Level Connection using the proper procedure as described in Section 4.2.
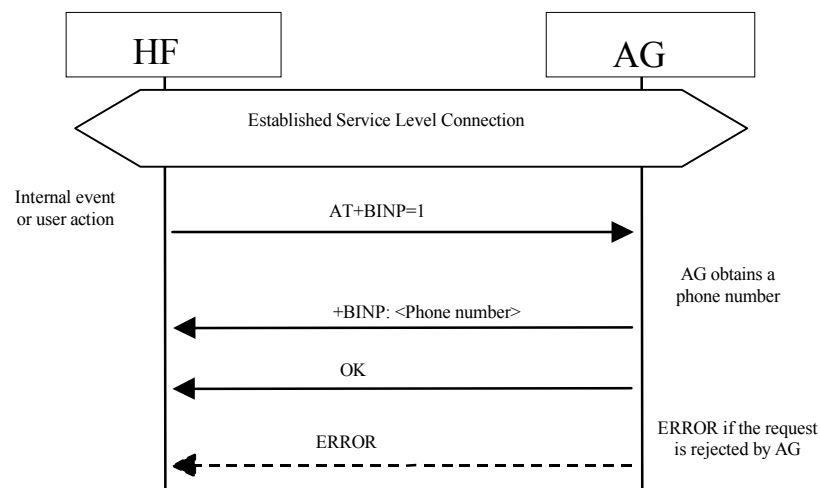
Figure 4.28 Request phone number to the AG

4.22 Transmit DTMF Codes

During an ongoing call, the HF transmits the `AT+VTS` command to instruct the AG to transmit a specific DTMF code to its network connection.

Refer to Section 4.24 for more information on the `AT+VTS` command.

Bluetooth

The following pre-conditions apply for this procedure:

- An ongoing Service Level Connection between the AG and the HF shall exist. If this connection does not exist, the HF shall autonomously establish the Service Level Connection using the proper procedure as described in Section 4.2.

- An ongoing call in the AG exists.
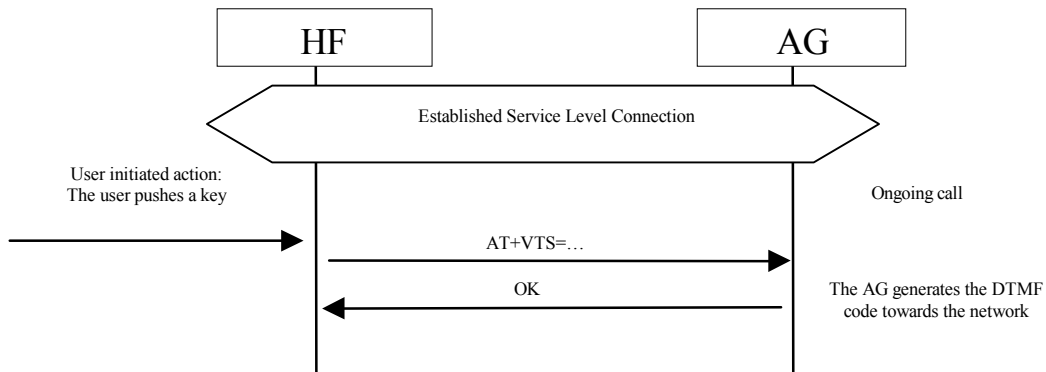
Figure 4.29 Transmit DTMF code

4.23 Remote Audio Volume Control

4.23.1 Audio Volume Control

This procedure enables the user to modify the speaker volume and microphone gain of the HF from the AG.

The AG may control the gain of the microphone and speaker of the HF by sending the unsolicited result codes +VGM and +VGS respectively. There is no limit in the amount and order of result codes.

If the remote audio volume control feature is supported in the HF device, it shall support at least remote control of the speaker volume.

As pre-condition for this procedure, an ongoing Service Level Connection between the AG and the HF shall exist. If this connection does not exist, the AG shall autonomously establish the Service Level Connection using the proper procedure as described in Section 4.2.

An audio connection is not a necessary pre-condition for this feature.
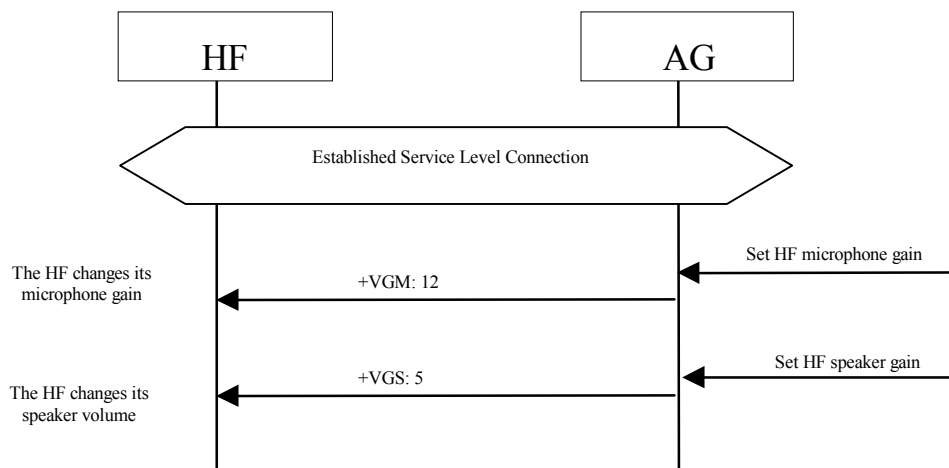
Figure 4.30 Typical example of audio volume control

Both the speaker and microphone gains are represented as parameter to the `+VGS` and `+VGM`, on a scale from 0 to 15. The values are absolute values, and relate to a particular (implementation dependent) volume level controlled by the HF.

Refer to Section 4.24 for more information on these commands and unsolicited result codes.

4.23.2 Volume Level Synchronization

This procedure allows the HF to inform the AG of the current gain settings corresponding to the HF's speaker volume and microphone gain.

On Service Level Connection establishment, the HF shall always inform the AG of its current gain settings by using the AT commands `AT+VGS` and `AT+VGM`.

If local means are implemented on the HF to control the gain settings, the HF shall also use the AT commands `AT+VGS` and `AT+VGM` to permanently update the AG of changes in these gain settings.

In all cases, the gain settings shall be kept stored, at both sides, for the duration of the current Service Level Connection. Moreover, if the Service Level Connection is released as a consequence of an HF initiated "Audio Connection transfer towards the AG", as stated in section 4.12, the HF shall also keep the gain settings and re-store them when the Service Level Connection is re-established again.

The HF is only mandated to support microphone gain synchronization when it supports remote microphone gain control.

Bluetooth

As pre-condition for this procedure, an ongoing Service Level Connection between the AG and the HF shall exist. If this connection does not exist, the HF shall autonomously establish the Service Level Connection using the proper procedure as described in Section 4.2.
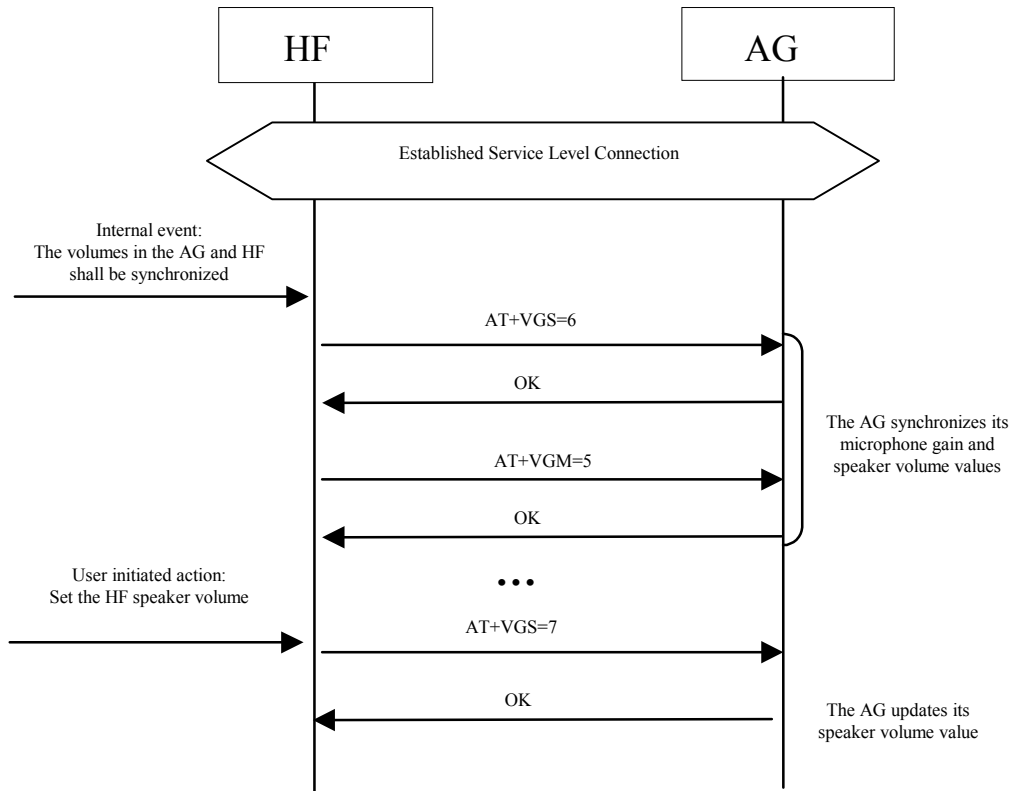
Figure 4.31 Typical example of volume level synchronization

Refer to Section 4.24 for more information on these commands and unsolicited result codes.

4.24 AT Commands and Result Codes

4.24.1 General

For the exchange of the commands and unsolicited results codes, the format, syntax and procedures of GSM 07.07 [2] shall be taken as reference. The following rules specifically apply for the HFP specification:

• Only one command (or unsolicited result code) per command line needs to be expected.

• The AG, by default, shall not echo the command characters.

• The AG shall always transmit result codes using verbose format.

- The characters below shall be used for AT commands and result codes formatting:

    <cr> corresponds to the *carriage return (0/13)* as stated in [7]

    <lf> corresponds to the *line feed (0/10)* as stated in [7].

- The format of an AT command from the HF to the AG shall be:

    <AT command><cr>

- The format of the OK code from the AG to the HF shall be:

    <cr><lf>OK<cr><lf>

- The format of the generic ERROR code from the AG to the HF shall be:

    <cr><lf>ERROR<cr><lf>

- The format of an unsolicited result code from the AG to the HF shall be:

    <cr><lf><result code><cr><lf>

The Hands-Free Profile uses a subset of AT commands and result codes from existing standards; these are listed in Section 4.24.2. Section 4.24.3 lists the new Bluetooth defined AT commands and result codes not re-used from any existing standard.

In general, the AG shall use the OK code, as described in Section 4.24.2, for acknowledgement of the proper execution of a command and respond with the proper error indication to any unknown command received from the HF.

It is mandatory for the AG to properly respond to any error condition and for the HF to properly process the corresponding error indication code received from the AG. The code ERROR, as described in Section 4.24.2, shall be used as error indication for this purpose.

The HF shall always ignore any unknown or unexpected indication code received from the AG. The only exception is the case in which the AG issues a "Mobile Equipment Error" indication using the +CME ERROR: result code (see section 9.1 in [2]). In this case, the HF shall interpret this result code in the same way as if it was a generic ERROR code.

Bluetooth

As a general rule, when an AT command or result code of this specification is implemented, support for the associated parameters "covered" in this specification, and all their corresponding possible values, shall be considered mandatory unless otherwise explicitly stated in each particular case.

4.24.2 AT Capabilities Re-Used from GSM 07.07

The re-used AT commands and unsolicited result codes for implementing the functionality described in this specification are listed below:

As a convention, if a parameter of an AT command or result code is not "covered" in this specification, it shall not be present in the corresponding AT command, and the HF shall ignore the parameter whenever it is received in a result code.

- **ATA**

    Standard call answer AT command. Refer to Section 6.20 in [2].

- **ATDdd…dd;**

    Standard AT command intended for placing a call to a phone number. Only voice calls are covered in this specification. Refer to Section 6.2 in [2].

- **ATD>nnn;**

    Extension of the standard ATD command, intended for memory dialing. Only voice calls are covered in this specification. Refer to Section 6.3 in [2].

- **ERROR**

    Standard error indication code. It shall be issued on detection of any syntax, format or procedure error condition. The "Mobile Equipment Error" report code "+CME ERROR:" is not covered in this specification. Refer to Annex B in [2].

- **OK**

    Standard acknowledgement to the execution of a command. Refer to Annex B in [2].

- **RING**

Standard "incoming call" indication. Refer to Annex B in [2].

- **AT+CCWA**

  Standard "Call Waiting notification" AT command. Within the
  `AT+CCWA=[<n>[,<mode>[,<class>]]]` command, only
  enabling/disabling of the Call Waiting notification unsolicited result code
  `+CCWA` , using the `<n>` parameter, is covered in this specification. Refer
  to Section 7.11 in [2].

- **+CCWA**

  Standard "Call Waiting notification" unsolicited result code.

  In the `+CCWA: <number>, <type>, <class>` result code. Only the
  `<number>=calling phone number digits`, `<type>=type of
  address` and `<class>=voice` parameters are covered in this
  specification. Anyway, the value of the `<type>` parameter is not
  considered relevant in this specification and shall be ignored by the HF,
  together with any of the non-covered parameters received.

  Refer to Section 7.11 in [2].

- **AT+CHLD**

  Standard call hold and multiparty handling AT command. In the
  `AT+CHLD=<n>` command, this specification only covers values for <n>
  of 0, 1, 2, 3 and 4, where:

  > 0 = Releases all held calls or sets User Determined User Busy
  >   (UDUB) for a waiting call.

  > 1 = Releases all active calls (if any exist) and accepts the other
  >   (held or waiting) call.

  > 2 = Places all active calls (if any exist) on hold and accepts the
  >   other (held or waiting) call.

  > 3 = Adds a held call to the conversation.

  > 4 = Connects the two calls and disconnects the subscriber from
  >   both calls (Explicit Call Transfer). Support for this value and
  >   its associated functionality is optional for the HF.

The test command `AT+CHLD=?` may be used for retrieving information about the call hold and multiparty services available in the AG (refer to Section 4.2.1).

Refer to Section 7.6 in [2] and Section 4.5.5.1 in [9] for details.

- **AT+CHUP**

  Standard hang-up AT command. Refer to Section 6.5 in [2].

- **AT+CIND**

  Standard indicator update AT command. Only read command `AT+CIND?` and test command `AT+CIND=?` are required in this specification.

  The `AT+CIND?` read command is used to get current status of the AG indicators.

  The `AT+CIND=?` test command is used to retrieve the mapping between each indicator supported by the AG and its corresponding range and order index. It shall be issued at least once before any other command related to these indicators (`AT+CIND?` or `AT+CMER`) is used.

  The following indicators are covered in this specification:

  - `service`: Service availability indication, where:

    <value>=0 implies no service. No Home/Roam network available.

    <value>=1 implies presence of service. Home/Roam network available

  - `call`: Standard call status indicator, where:

    <value>=0 means no call active

    <value>=1 means a call is active.

  - `callsetup`: Bluetooth proprietary call set up status indicator[1]. Support for this indicator is optional for the HF. When supported, this indicator shall be used in conjunction with, and as an extension of the standard `call` indicator. Possible values are as follows:

    <value>=0 means not currently in call set up.

    <value>=1 means an incoming call process ongoing.

---

[1] This status indicator is not defined in the GSM 07.07 specification

<value>=2 means an outgoing call set up is ongoing.

<value>=3 means remote party being alerted in an outgoing call.

Refer to Section 8.9 in [2].

- **AT+CLIP**

  Standard "Calling Line Identification notification" activation AT command. It enables/disables the Calling Line Identification notification unsolicited result code `+CLIP`. Refer to Section 7.6 in [2].

- **+CLIP**

  Standard "Calling Line Identification notification" unsolicited result code.

  In the `+CLIP: <number>, type> [,<subaddr>,<satype> [,[<alpha>] [,<CLI validity>]]]` result code. Only `<number>=calling phone number digits` and `<type>=type of address` parameters are covered in this specification. Anyway, the value of the `<type>` parameter is not considered relevant in this specification and shall be ignored by the HF, together with any of the non-covered parameters received.

  Refer to Section 7.11 in [2].

- **AT+CMER**

  Standard event reporting activation AT command. Only activation of the "indicator events reporting" result code `+CIEV` is covered in this specification.

  In the `AT+CMER=[<mode>[,<keyp>[,<disp>[,<ind> [,<bfr>]]]]]` command, only the `<mode>`, and `<ind>` parameters are relevant for this specification. Only their values `<mode>=(0,3)` and `<ind>=(0,1)` are covered in this specification. Refer to Section 8.10 in [2].

  The following examples show how the `AT+CMER` command may be used for activating or deactivating the "indicator events reporting" result code:

  `AT+CMER=3,0,0,1` activates "indicator events reporting".

  `AT+CMER=3,0,0,0` deactivates "indicator events reporting".

- **+CIEV**

    Standard "indicator events reporting" unsolicited result code.

    In the `+CIEV: <ind>,<value>` result code, only the indicators stated in the `AT+CIND` command above are relevant for this specification where:

    - `<ind>`: Order index of the indicator within the list retrieved from the AG with the `AT+CIND=?` command. The first element of the list shall have `<ind>=1`.

    - `<value>`: current status of the indicator.

    If the HF receives any unknown indicator or value, it shall ignore it.

    Refer to Section 8.10 in [2].

- **AT+VTS**

    Standard DTMF generation AT command. Only the `AT+VTS=<DTMF>` command format is covered in this specification.

    Refer to Annex C.2.11 in [2].

4.24.3 Bluetooth Defined AT Capabilities

The GSM 07.07 [2] format and syntax rules shall be taken as the reference for these commands.

The new Bluetooth specific AT capabilities are listed below:

- **AT+BINP** *(Bluetooth INPut)*

    Syntax: AT+BINP=<datarequest>

    Expected response: +BINP: <dataresp$_1$>…<dataresp$_n$>

    Description:

    > Command used for requesting some specific data input from the AG[2]. On reception of this command the AG shall perform the proper actions such that the requested information is sent back to the HF using the `+BINP` response.

    > The type of data the HF shall expect in the <dataresp> parameter returned by the AG depends on the information requested in each case.

---

[2] AT+BINP was created with future extensibility in mind. While the Hands-Free Profile only specifies a <datarequest> value of 1 (i.e. phone number), future profiles my choose to add values for <datarequest> to support the retrieval of additional data from the AG.

Only support for execution command is mandated. Neither the read nor test commands are mandatory

Values:

<datarequest>: 1, where

1 = Phone number corresponding to the last voice tag recorded in the HF.

<dataresp$_{1..n}$>: Data parameters returned by the AG. Their contents depends on the value of the <datarequest> parameter as follows:

<datarequest> value	<dataresp> parameters
1	<Phone number>:
	Phone number string (max. 32 digits). The format (type of address) of the phone number string shall conform with the rules stated in [8], sub-clause 10.5.4.7, for a value (in integer format) of the *type of address octet* of 145, if dialling string includes international access code character "+", and for a value of 129 otherwise.

- **AT+BLDN** *(Bluetooth Last Dialed Number)*

  Syntax: AT+BLDN

  Description:

  Command used for calling the last phone number dialed. On reception of this command, the AG shall set up a voice call to the last phone number dialed.

  Only support for execution command is mandated. Neither the read nor test commands are mandatory

- **AT+BVRA** *(Bluetooth Voice Recognition Activation)*

  Syntax: AT+BVRA=<vrec>

  Description:

  Enables/disables the voice recognition function in the AG.

  Only support for execution command is mandated. Neither the read nor test commands are mandatory

  Values:

  <vrec>: 0, 1, entered as integer values, where

  0 = Disable Voice recognition in the AG

  1 = Enable Voice recognition in the AG

- **+BVRA** *(Bluetooth Voice Recognition Activation)*

    Syntax: +BVRA: <vrect>

    Description:

    > Unsolicited result code used to notify the HF when the voice recognition function in the AG is activated/deactivated autonomously from the AG.

    > The unsolicited +BVRA:1 result code shall not be sent by the AG to the HF if the corresponding voice recognition activation has been initiated by the HF. Likewise, the unsolicited +BVRA:0 result code shall not be sent by the AG to the HF if the corresponding voice recognition deactivation has been initiated by the HF, regardless of which side initiated the voice recognition activation.

    Values:

    > <vrect>: 0, entered as integer value, where

    >> 0 = Voice recognition is disabled in the AG

    >> 1 = Voice recognition is enabled in the AG

- **AT+BRSF** *(Bluetooth Retrieve Supported Features)*

    Syntax: AT+BRSF=<HF supported features bitmap>

    Description:

    > Notifies the AG of the supported features available in the HF, and requests information about the supported features in the AG. The supported features shall be represented as a decimal value.

    Values:

    > <HF supported features bitmap>: a 32 bit unsigned integer representing a bitmap of the supported features in the HF as follows:

Bit	Feature
0	EC and/or NR function
1	Call waiting and 3-way calling
2	CLI presentation capability
3	Voice recognition activation
4	Remote volume control
5-31	Unused (available for PAP and other extensibility)

    > The unused bits (5-31) shall be initialized to Zero.

- **+BRSF** *(Bluetooth Retrieve Supported Features)*

    Syntax: +BRSF: <AG supported features bitmap>

    Description:

    Result code sent by the AG in response to the AT+BRSF command, used to notify the HF what features are supported in the AG. The supported features shall be represented as a decimal value.

    Values:

    <AG supported features bitmap>: a 32 bit unsigned integer representing a bitmap of the supported features in the AG as follows:

Bit	Feature
0	Three-way calling
1	EC and/or NR function
2	Voice recognition function
3	In-band ring tone capability
4	Attach a number to a voice tag
5	Ability to reject a call
6-31	Unused (available for PAP and other extensibility)

    The unused bits (6-31) shall be initialized to Zero.

- **AT+NREC** *(Noise Reduction and Echo Canceling)*

    Syntax: AT+NREC=<nrec>

    Description:

    Command issued to disable any Echo Canceling and Noise Reduction functions embedded in the AG.

    Only support for execution command is mandated. Neither the read nor test commands are mandatory.

    Values:

    <nrec>: 0, entered as integer value, where

    > 0 = Disable EC/NR in the AG

- **AT+VGM** *(Gain of Microphone)*

    Syntax: AT+VGM=<gain>

    Description:

    Command issued by the HF to report its current microphone gain level setting to the AG. <gain> is a decimal numeric constant, relating to a particular (implementation dependent) volume level

controlled by the HF. This command does not change the microphone gain of the AG; it simply indicates the current value of the microphone gain in the HF.

Only support for execution command is mandated. Neither the read nor test commands are mandatory

Values:

> <gain>: 0 -15, entered as integer values, where
>
>> 0 = Minimum gain
>>
>> 15 = Maximum gain

- **AT+VGS** *(Gain of Speaker)*

  Syntax: AT+VGS=<gain>

  Description:

  > Command issued by the HF to report its current speaker gain level setting to the AG. <gain> is a decimal numeric constant, relating to a particular (implementation dependent) volume level controlled by the HF. This command does not change the speaker gain of the AG; it simply indicates the current value of the speaker volume in the HF.

  > Only support for execution command is mandated. Neither the read nor test commands are mandatory

  Values:

  > <gain>: 0 -15, entered as integer values, where
  >
  >> 0 = Minimum gain
  >>
  >> 15 = Maximum gain

- **+VGM** *(Gain of Microphone)*

  Syntax: +VGM:<gain>

  Description:

  > Unsolicited result code issued by the AG to set the microphone gain of the HF. <gain> is a decimal numeric constant, relating to a particular (implementation dependent) volume level controlled by the HF.

  > Due to the small inconsistency between the GSM 07.07 standard ([2]) and the current Headset specification ([4]), the HF shall also accept the "**=**" symbol, in place of "**:**", as a valid separator for this unsolicited result code.

  Values:

Bluetooth

<gain>: 0 -15, integer values, where

0 = Minimum gain

15 = Maximum gain

- **+VGS** *(Gain of Speaker)*

    Syntax: +VGS:<gain>

    Description:

    Unsolicited result code issued by the AG to set the speaker gain of the HF. <gain> is a decimal numeric constant, relating to a particular (implementation dependent) volume level controlled by the HF.

    Due to the small inconsistency between the GSM 07.07 standard ([2]) and the current Headset specification ([4]), the HF shall also accept the "**=**" symbol, in place of "**:**", as valid separator for this unsolicited result code.

    Values:

    <gain>: 0 -15, integer values, where

    0 = Minimum gain

    15 = Maximum gain

- **+BSIR** *(Bluetooth Setting of In-band Ring tone)*

    Syntax: +BSIR: <bsir>

    Description:

    Unsolicited result code issued by the AG to indicate to the HF that the in-band ring tone setting has been locally changed. The HF may react accordingly by changing its own alert method.

    Values:

    <bsir>: 0 = the AG provides no in-band ring tone

    1 = the AG provides an in-band ring tone

5   Serial Port Profile

This profile requires compliance to the Serial Port Profile [6]. The following text together with the associated sub-clauses defines the requirements with regard to this profile in addition to the requirements as defined in the Serial Port Profile.

For the Hands-Free Profile, both the AG and the HF may initiate connection establishment. Therefore, for the purposes of reading the Serial Port Profile [6], both the AG and the HF may assume the role of Device A or B.

5.1   RFCOMM Interoperability Requirements

For the RFCOMM layer, no additions to the requirements as stated in the Serial Port Profile [6] Section 4 apply.

5.2   L2CAP Interoperability Requirements

For the L2CAP layer, no additions to the requirements as stated in the Serial Port Profile [6] Section 5 apply.

5.3 SDP Interoperability Requirements

The following service records are defined for the Hands-Free Profile. There is one service record applicable to the Hands-Free unit and another for the Audio Gateway.

The attribute "SupportedFeatures" states the features supported in each device. This attribute is not encoded as a data element sequence; it is simply a 16-bit unsigned integer. The set of features supported in each case is bit-wise defined in this attribute on a yes/no basis. The mapping between the features and their corresponding bits within the attribute is listed below in Table 5.2 for the HF and in Table 5.4 for the AG. If a device indicates support for a feature, then it shall support that feature in the manner specified by this Profile, and be subject to verification as part of the Bluetooth Qualification Program.

The codes assigned to the mnemonics used in the Value column, as well as the codes assigned to the attribute identifiers (if not specifically mentioned in the AttrID column), are listed in the Bluetooth Assigned Numbers document of the current Bluetooth Specification.

The values of the "SupportedFeatures" bitmap given in Table 5.2 shall be the same as the values of the Bits 0 to 4 of the AT-command `AT+BRSF` (see Section 4.24.3).

Item	Definition	Type	Value	Status	Default
ServiceClassIDList				M	
ServiceClass0		UUID	Hands-Free	M	
ServiceClass1		UUID	Generic Audio	M	
ProtocolDescriptorList				M	
Protocol0		UUID	L2CAP	M	
Protocol1		UUID	RFCOMM	M	
ProtocolSpecificParameter0	Server Channel	Uint8	N=server channel #	M	
BluetoothProfileDescriptorList				O	
Profile0	Supported Profiles	UUID	Hands-Free	M	Hands-Free
Param0	Profile Version	Uint16	0x0101[3]	M	0x0101
ServiceName	Display-able Text name	String	*Service-provider defined*	O	"Hands-Free unit"
SupportedFeatures	Features supported	Uint16	*Device dependent*	M	0x0000

Table 5.1 Service Record for the HF

---

[3] Indicating version 1.01

Bluetooth

Bit position (0=LSB)	Feature	Default in HF
0	EC and/or NR function (yes/no, 1 = yes, 0 = no)	0
1	Call waiting and three way calling(yes/no, 1 = yes, 0 = no)	0
2	CLI presentation capability (yes/no, 1 = yes, 0 = no)	0
3	Voice recognition activation (yes/no, 1= yes, 0 = no)	0
4	Remote volume control (yes/no, 1 = yes, 0 = no)	0

Table 5.2 "SupportedFeatures" attribute bit mapping for the HF

The "Network" attribute states, if the AG has the capability to reject incoming calls[4]. This attribute is not encoded as a data element sequence; it is simply an 8-bit unsigned integer. The information given in the "Network" attribute shall be the same as the information given in Bit 5 of the unsolicited result code `+BRSF` (see Section 4.24.3). An attribute value of 0x00 is translated to a bit value of 0; an attribute value of 0x01 is translated to a bit value of 1.

The values of the "SupportedFeatures" bitmap given in Table 5.4 shall be the same as the values of the Bits 0 to 4 of the unsolicited result code `+BRSF` (see Section 4.24.3).

Item			Definition	Type	Value	Status	Default
ServiceClassIDList						M	
	ServiceClass0			UUID	AG Hands-Free	M	
	ServiceClass1			UUID	Generic Audio	M	
ProtocolDescriptorList						M	
	Protocol0			UUID	L2CAP	M	
	Protocol1			UUID	RFCOMM	M	
		ProtocolSpecificParameter0	Server Channel	Uint8	N=server channel #	M	
BluetoothProfileDescriptorList						O	
	Profile0		Supported Profiles	UUID	Hands-Free	M	Hands-Free
		Param0	Profile Version	Uint16	0x0101[5]	M	0x0101
ServiceName			Display-able Text name	String	*Service-provider defined*	O	"Voice gateway"
Network				Uint8	0x01 – Ability to reject a call 0x00 – No ability to reject a call	M	
SupportedFeatures			Features supported	Uint16	*Device dependent*	M	

Table 5.3 Service Record for the AG

---

[4] In previous versions of the Hands-Free Profile, the attribute values were called "GSM like" and "others".
[5] Indicating version 1.01

Bit position (0=LSB)	Feature	Default in AG
0	Three-way calling (yes/no, 1 = yes, 0 = no)	1
1	EC and/or NR function (yes/no, 1 = yes, 0 = no)	0
2	Voice recognition function (yes/no, 1 = yes, 0 = no)	0
3	In-band ring tone capability (yes/no, 1 = yes, 0 = no)	1
4	Attach a phone number to a voice tag (yes/no, 1 = yes, 0 = no)	0

Table 5.4 "SupportedFeatures" attribute bit mapping for the AG

5.3.1 Interaction with Hands-Free Profile Rev 0.96 Implementations

HF implementations, which are according to the Hands-Free Profile specification Rev. 0.96, will not send the AT+BRSF command. Likewise, AG implementations, which are according to the Hands-Free Profile specification Rev. 0.96, will not be able to respond to AT+BRSF with the +BRSF unsolicited result code. Instead they will respond with ERROR.

In order to retrieve the "SupportedFeatures" information from an HF, which does not send AT+BRSF, Service Discovery should be used by the AG implementation. Whenever the "SupportedFeatures" attribute is not present in the HF service record, or if the AG does not perform the Service Discovery procedure, default values as stated in Table 5.2 shall be assumed.

In order to retrieve the "SupportedFeatures" and "Network" information from an AG, which does not send +BRSF, Service Discovery should be used by the HF implementation. Whenever the "SupportedFeatures" attribute is not present in the AG service record, or if the HF does not perform the Service Discovery procedure, default values as stated in Table 5.4 shall be assumed.

5.4 Link Manager (LM) Interoperability Requirements

In addition to the requirements for the Link Manager as stated in the "Serial Port Profile" [6] on page 165, this profile mandates support for SCO links[6] in both the HF and the AG.

---

[6] See "Baseband Specification" in [1] for information on the mandated and optional packet types.

5.5 Link Control (LC) Interoperability Requirements

In the table below, changes to the support status as listed in the Serial Port Profile [6], Section 8.1, Table 8.1 are listed.

	Capability	**Support in AG**	**Support in HF**
1.	Inquiry		N/A
2.	Inquiry scan	N/A	
7	Voice CODEC		
C	CVSD	M	M

Table 5.5 LC capabilities

5.5.1 Class of Device

A device implementing the HF role of HFP shall set the "Audio" bit in the Service Class field. Optionally, if the HF intends to be discovered as a "Hands-Free", it may use the following values in the Class of Device field:

1. Indicate "Audio" as Major Device class

2. Indicate "Hands-Free" as the Minor Device class.

An inquiring AG may use this information to filter the inquiry responses.

Bluetooth

6 Generic Access Profile

This section defines the support requirements for the capabilities as defined in the "Generic Access Profile" [5].

6.1 Modes

The table shows the support status for GAP Modes in this profile.

Procedure	Support in HF
General discoverable mode	M
Procedure	**Support in AG**
Pairable mode	M

Table 6.1 Modes

6.2 Security Aspects

There are no changes to the security requirements as stated in the Generic Access Profile [5].

6.3 Idle Mode Procedures

Table 6.2 shows the support status for Idle mode procedures within this profile

Procedure	Support in AG
Initiation of general inquiry	M
Initiation of general bonding	M
Initiation of dedicated bonding	M

Table 6.2 Idle mode procedures

7   References

[1]   "Specification of the Bluetooth System; Core, v1.1"

[2]   ETS 300 916, "Digital cellular telecommunications system (Phase 2+); AT command set for GSM Mobile Equipment (ME) (GSM 07.07 version 7.5.0)"

[3]   -removed-

[4]   "Specification of the Bluetooth System; Profiles, v1.1, Part K:6, Headset Profile"

[5]   "Specification of the Bluetooth System; Profiles, v1.1, Part K:1, Generic Access Profile"

[6]   "Specification of the Bluetooth System; Profiles, v1.1, Part K:5, Serial Port Profile"

[7]   "ITU-T50, Terminal Equipment and Protocols for telematic services: International Reference Alphabet (IRA) (Formerly International Alphabet No. 5 IA5). Information technology – 7-Bit coded character set for information interchange"

[8]   "Digital cellular telecommunication system (Phase 2+); Mobile radio interface layer 3 specification", (GSM 04.08 version 6.11.0).

[9]   "GSM 02.30 (version 7.1.0): Digital cellular telecommunications system (Phase 2+); Man-Machine Interface (MMI) of the Mobile Station (MS)"

8   List of Acronyms and Abbreviations

Abbreviation or Acronym	Meaning
AG	Audio Gateway
AT	Attention
CLI	Calling Line Identification
CODEC	COder DECoder
CVSD	Continuous Variable Slope Delta modulation
DTMF	Dual Tone Multi-Frequency
EC	Echo Cancellation
GAP	Generic Access Profile
GSM	Global System for Mobile communication
HF	Hands-Free unit
L2CAP	Logical Link Control and Adaptation Protocol
LMP	Link Manager Protocol
NR	Noise Reduction
OSI	Open System Interconnection
PIN	Personal Identification Number
RFCOMM	Serial port transport protocol over L2CAP
SCO	Synchronous Connection Oriented
SDP	Service Discovery Protocol
UI	User Interface
UUID	Universal Unique Identifier

9   List of Figures

10 List of Tables