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MCPC TR-027

Bluetooth SBC Parameters Recommendation

Technical Reference

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History

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1. Introduction

1.1 Scope

Bluetooth entertainment audio has become quite popular. For the audio streaming, SBC (Sub Band Codec) is now widely used as mandatory codec with the recommended encoder settings (especially Bitpool value) described in 'Advanced Audio Distribution Profile (A2DP) v1.3.2' as quoted as followings.

For the encoder of the **SRC**, it is required to support at least one possible bitpool value. However, it is recommended for the encoder to support the following settings shown in Table 4.7.

SBC encoder settings*	Middle Quality				High Quality			
	Mono		Joint Stereo		Mono		Joint Stereo	
Sampling frequency (kHz)	44.1	48	44.1	48	44.1	48	44.1	48
Bitpool value	19	18	35	33	31	29	53	51
Resulting frame length (bytes)	46	44	83	79	70	66	119	115
Resulting bit rate (kb/s)	127	132	229	237	193	198	328	345
*Other settings: Block length = 16, Allocation method = Loudness, Subbands = 8								

Table 4.7: Recommended sets of SBC parameters in the SRC device

The decoder of the SNK shall support all possible bitpool values that do not result in excess of the maximum bit rate. This profile limits the available maximum bit rate to 320kb/s for mono, and 512kb/s for two-channel modes.

Those SBC encoder settings are optimized for Bluetooth Classic BR (Basic Rate) core although it becomes major to use EDR (Enhanced Data Rate). The issue is that the SBC encoder settings optimized for BR is nevertheless applied to EDR in most case. It causes inefficiency of air use to transfer audio data on EDR and SBC's codec rate is suppressed in lower level of which audiophile complains.

To solve the issue, this document newly recommends to use optimized SBC codec settings for EDR in place of Table 4.7 in A2DP v1.3.2'. It makes audio quality better without special effort.

2. Overview of proposal

This Technical Reference document newly proposes ‘Recommendation of SBC parameters setting in the SRC for EDR’ and Media payload forming manner to enable efficient SBC frames stuffing into single 2-DH5 packet that is essential for the recommendation. This is an extension of the existing recommendation in ‘Advanced Audio Distribution v1.3.2’ (Table 4.7) that is optimized for BR. Additionally, it also recommends that SRC supports selection menu of the SBC settings in association with the proposal.

2.1 Proposal A: New SBC encoder settings for EDR

Table 5.1 Recommended sets of SBC parameters in the SRC for EDR

2.2 Proposal B: Media payload forming to fit to ACL packet

Recommendation of the most efficient media frame forming to fit to the ACL packet for EDR that is to be applied with Proposal A

2.3 Proposal C: SRC device configuration for SBC encoder settings

Additional recommendation of SBC setting selection menu in SRC

3. Coverage of requirements

A2DP_v.1.0 or later (The latest version is 1.3.2)
- 4.3 SBC
- 5.2.1 Maximum Transmission Unit
- 5.5 Link Controller Interoperability Requirements

4. Problem definition

The low audio quality of the SBC codec is caused by artificial limitations of all current Bluetooth stacks and SNKs' configuration following the recommended sets of SBC parameters. But this limitation can be circumvented because SBC codec supports flexible parameters which can be selected by SRC.
Almost of existing SRC use the recommended higher quality audio parameters specified in Table 4.7 (328kbps or 345kbps, Joint Stereo). However, the recommended settings are not optimal for EDR devices in terms of audio quality and efficiency of air time which is occupied by audio streaming packets. The efficiency of air time affects coexistence performance and the number of retransmissions. More capacity for retransmissions (to make the audio streaming more reliable) provide more capacity for other applications in multi-profile/device scenario.
If new recommendation for EDR device is added in A2DP specification [1], it will enhance audio quality of SBC.

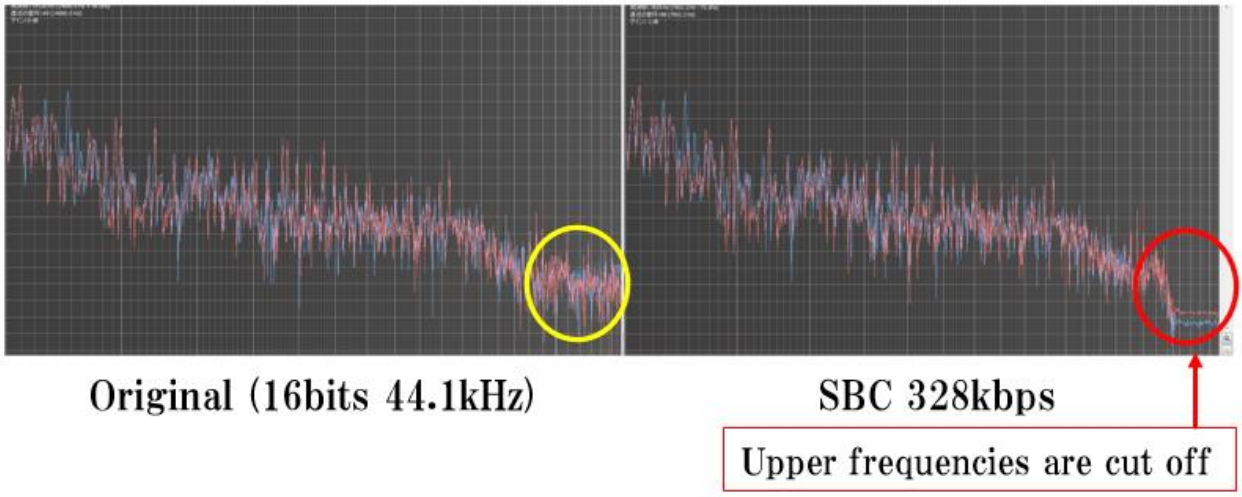


Figure 4.1: Frequency Response of Original and SBC 328kbps

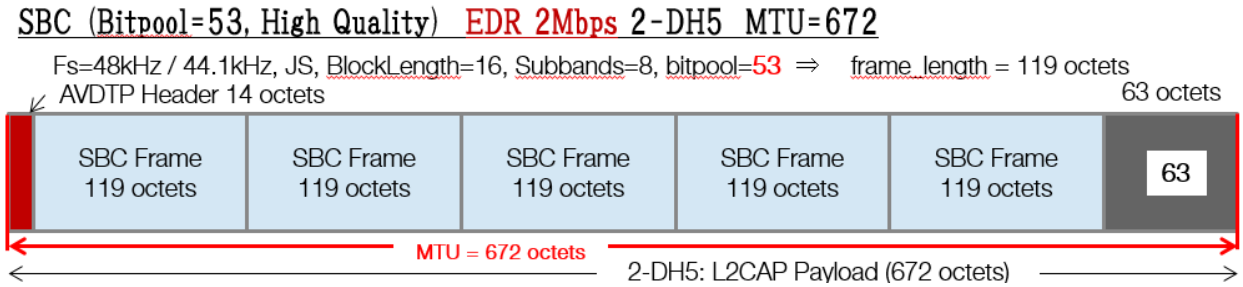
5. Description

SBC requires several different parameters to be negotiated during the connection setup phase. Followings are those parameters with all of mandatory elements to be supported in SNK which 'A2DP v1.3.2' specifies. (SNK is required to support any combinations of these parameters except for 16kHz and 32kHz sampling frequency. SRC is allowed to implement only a part of them.)

- Channel Mode: Joint Stereo, Stereo, Dual Channel, Mono
- Subbands: 4 or 8
- Block Length: 4, 8, 12, 16
- Allocation Method: Loudness, SNR
- Bitpool Value: 2 -250 (Allowed range; though usually seen 2-53)
- Sampling Frequency: 44.1kHz, 48kHz, 16kHz (Optional for SNK), 32kHz (Optional for SNK)

Majority of existing Bluetooth stacks usually negotiate the following profile: Joint Stereo, 8 bands, 16 blocks, Loudness, bitpool 53. This profile encodes 44.1kHz audio with a bitrate of 328kbps, as it is along recommendation in Table 4.7 of A2DP specification [1]. Though it is suitable for BR, not always best for EDR. An example is described below.

In the case that the same profile as BR is applied to EDR and SNK's MTU size for L2CAP media transport channel is 672 octets, five SBC frames are packed in a 2-DH5 packet. As SBC frame length is 119 octets and AVDTP header is 14 octets, 63 octets are wasted. (Please refer to "12.9 Calculation of Bit Rate and Frame Length in A2DP specification [1]" for frame length)



Figire.5.1: Transmission Efficiency example 1

As shown above, 63 octets room remains for a full 2-DH5 packet capacity in this case.
If the bitpool value 59 is applied, the SBC frame length is 131 octets and the wasted bytes are suppressed as 4 octets. From the perspective of the data transfer capability, the air resource consumption for bitpool value 59 is the same as that of 53. Since, the higher bitpool value provides the higher bitrate, it means that the better audio quality is available under the same air condition. Therefore, bitpool value 59 provides more efficient and better audio quality than 53.

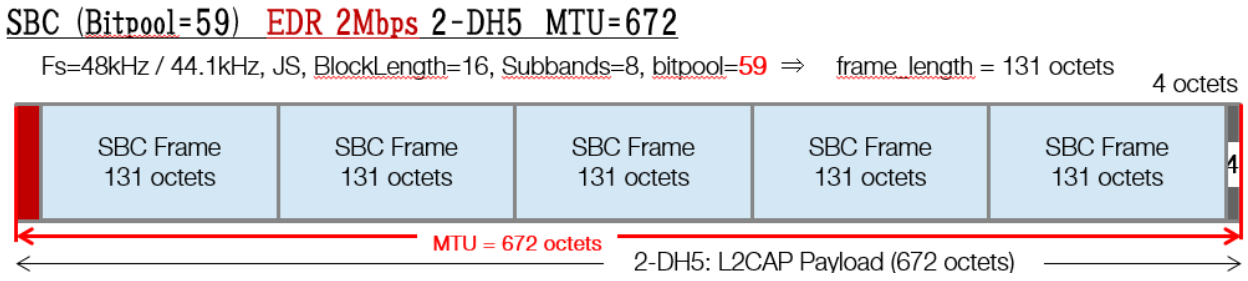


Figure 5.2 Transmission Efficiency example 2

Majority of SNK seems to limit maximum bitpool value as 53, which prevents bitrates higher than 328kbps to be used with the common 44.1kHz Joint Stereo, 8 subbands, 16 blocks length.
But the bitrate is also affected by other parameters.

For example, Subband 4 can get almost doubled bitrate than Subband 8 at the same bitpool value.

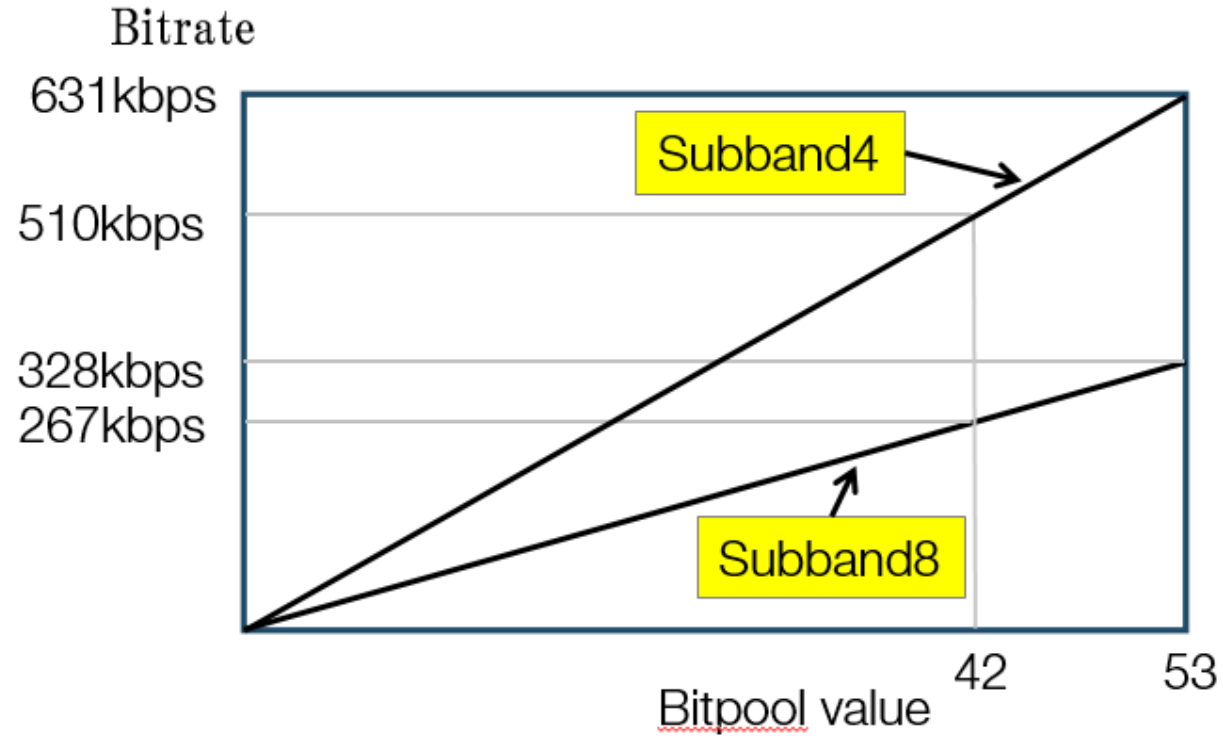


Figure 5.3: Bit Rate to the corresponding bit pool value (Subband 8 and 4)

Regarding the number of subband, 8 is better audio quality when the bitrate is lower. On the other hand 4 is better audio quality when the bitrate is higher. Because higher bitrate can allocate more bits to all bands and smaller number of bands can reduce filter bank aliasing noise, which is inherent to SBC.
Subjective evaluation showed that the cross point bitrate for stereo was between 400 and 450kbps.

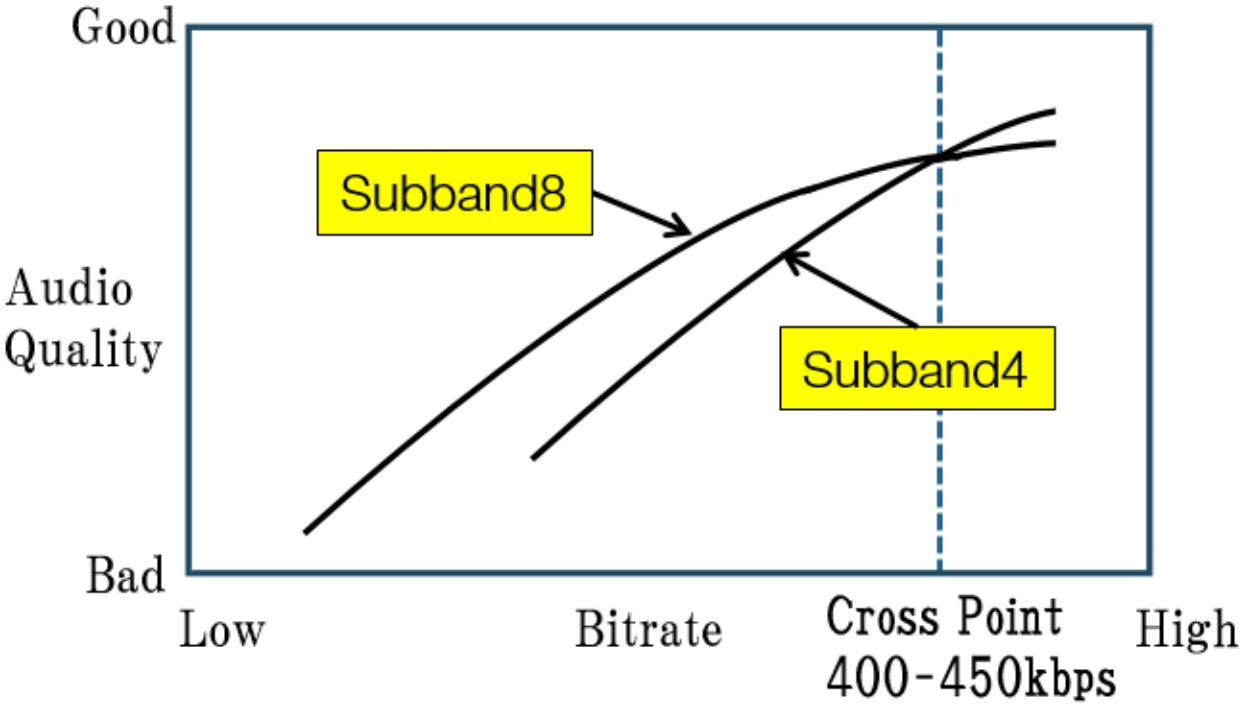


Figure 5.4: Audio Quality to Bit Rate (Subband 8 and 4)

Filter bank aliasing (Sine wave 1kHz)

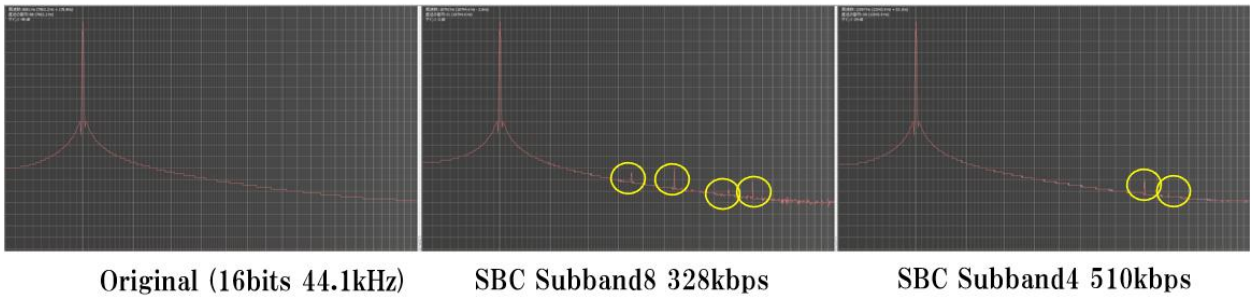


Figure 5.5: Filter Bank Aliasing Noise

The following example is air time to bit rate (bitpool) for subband 8 and 4 in case of EDR 2Mbps and 44.1kHz sampling frequency.
More efficient bitpool values in combination with appropriate number of the subband for EDR 2Mbps are 59 (361kbps) with subband 8, 75 (449kbps) with sububand 8 or 36 (444kbps) with subband4, and 42 (510kbps) with subband 4.
In this recommendation, 36 (444kbps) with subband 4 instead of 75 (449kbps) with sububand 8 is taken because the lower bitpool value can be accepted by majority of SNK whose maximum bitpool value is 53.

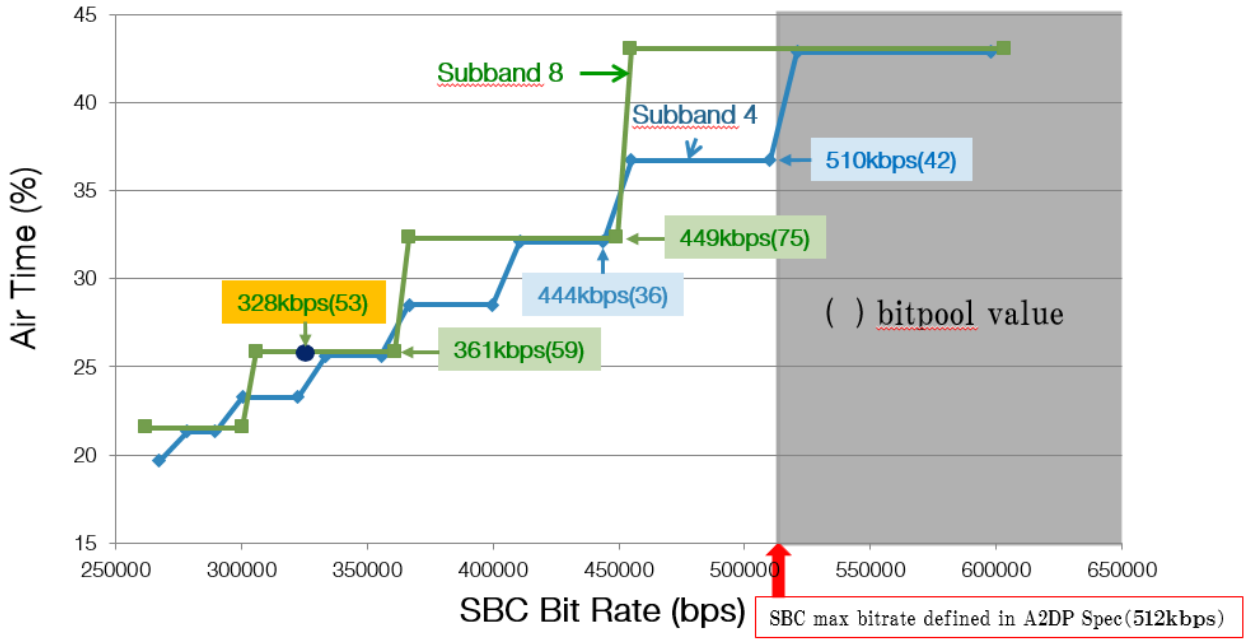


Figure 5.6: Air Time to SBC Bit Rate

SBC 328kbps completely cuts off upper frequencies often. Bitrate 510kbps saves the entire frequency range without cutting off.

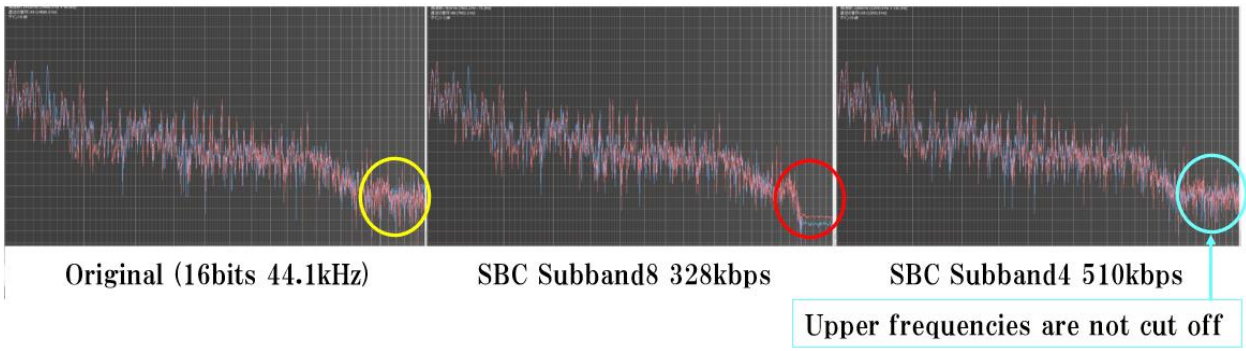


Figure 5.7: Improved Frequency Response

5.1 Proposal A: New SBC codec settings for EDR

The following table is “Recommended sets of SBC parameters in the SRC for EDR” additionally to the existing recommendation described in Table 4.7 of A2DP Specification [1].

The decoder of the SNK should support 59 as the Maximum Bitpool Value at a minimum.

SBC encoder settings*	EDR Low Quality Joint Stereo		EDR Middle Quality Joint Stereo		EDR High Quality Joint Stereo	
Sampling frequency (kHz)	44.1	48	44.1	48	44.1	48
Bitpool value	59	59	36	32	42	36
Resulting frame length (bytes)	131	131	81	73	93	81
Resulting bit rate (kb/s)	361	393	444	435	510	483
Subbands	8	8	4	4	4	4
*Other settings: Block length = 16, Allocation method = Loudness or SNR						

Table 5.1: Recommended sets of SBC parameters in the SRC (EDR)

5.2 Proposal B: Media payload forming to fit to ACL packet

SRC recognizes if the SNK supports BR only or EDR also in LMP supported features.

SRC should determine the SBC encoder settings depending that SNK supports BR only or EDR also.

In case both SRC and SNK support EDR, SRC should use EDR 2Mbps for media transport channel and use 2-DH5 packet for transporting media even when SNK supports EDR 3Mbps and 3-DH packet.

SRC should form media payload within the length of 672 octets even when SNK declares that the MTU size for media transport channel is greater than 672 octets. 672 octets fit to the payload size of 2-DH5 packet.

The minimum MTU of L2CAP for media transport channel in case of EDR should be 672 bytes.
(5.2.1 Maximum Transmission Unit in A2DP specification [1] specifies that the minimum MTU is 335 bytes).

All 2-DH and 2-DM packets should be supported for EDR in both SNK and SRC in addition to DH3, DM3, DH5, and DM5 which are stated in 5.5 Link Controller Interoperability Requirements of A2DP specification [1].

5.3 Proposal C: SRC device configuration for SBC codec settings

SRC should provide the selection menu of bitrate for each paired SNK to be interoperable with any SNK existing in market. (Not all existing SNK may be able to decode new recommended sets of SBC parameters). At least one possible BR recommendations (Table 4.7 in A2DP specification [1]) and one possible EDR recommendation shown in above table (Table 5.1) should be included in the selection menu. If SRC is not able to provide the selection menu, the recommendation for BR may be adopted.

References

[1] A2DP specification 1.0 or later from www.bluetooth.com

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