Opportunities and challenges for assistive listening with Bluetooth LE Audio and Auracast

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Disclaimers

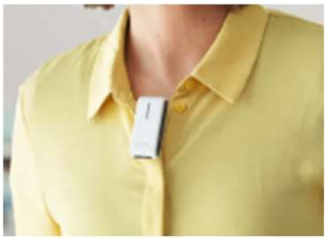
1. I am not a member of the Bluetooth Special Interest Group (SIG) or the Bluetooth Hearing Aid Working Group.
2. I am not an audiologist.

The situation in 2024

Made for iPhone

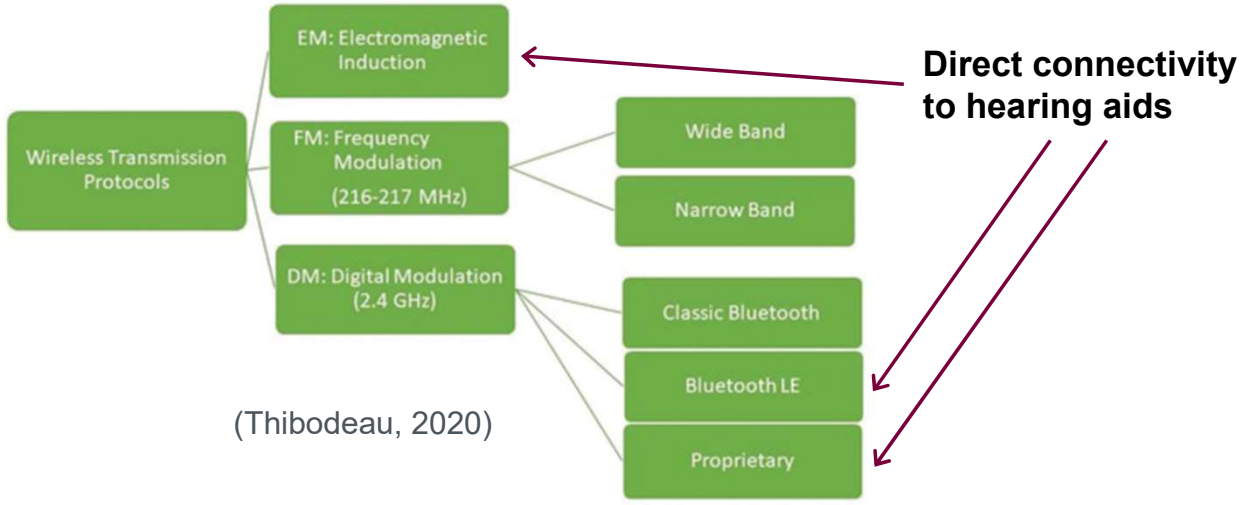
Bluetooth®

Audio Streaming for Hearing Aids



AURACAST
A BLUETOOTH® TECHNOLOGY

The situation in 2024



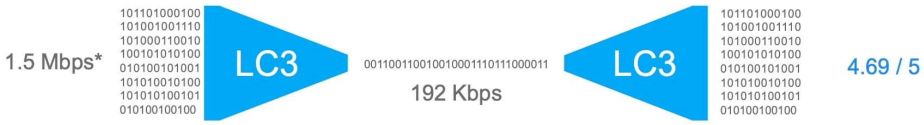
(Thibodeau, 2020)

What we will cover

1. What are Bluetooth LE Audio and Auracast, and how do they differ from previous versions of Bluetooth?
2. How can Auracast be used in different assistive listening scenarios, and what are the remaining challenges in developing standards and best practices for Auracast usage?
3. How will audiologists be able to advise and support their clients in obtaining the maximum benefit from Bluetooth LE Audio and Auracast?

Some terminology

- Bluetooth Protocol Stack: a set of protocols that enables devices to connect, communicate, and exchange data with each other
- Audio **codec**: a device or computer code for encoding/decoding an audio data stream

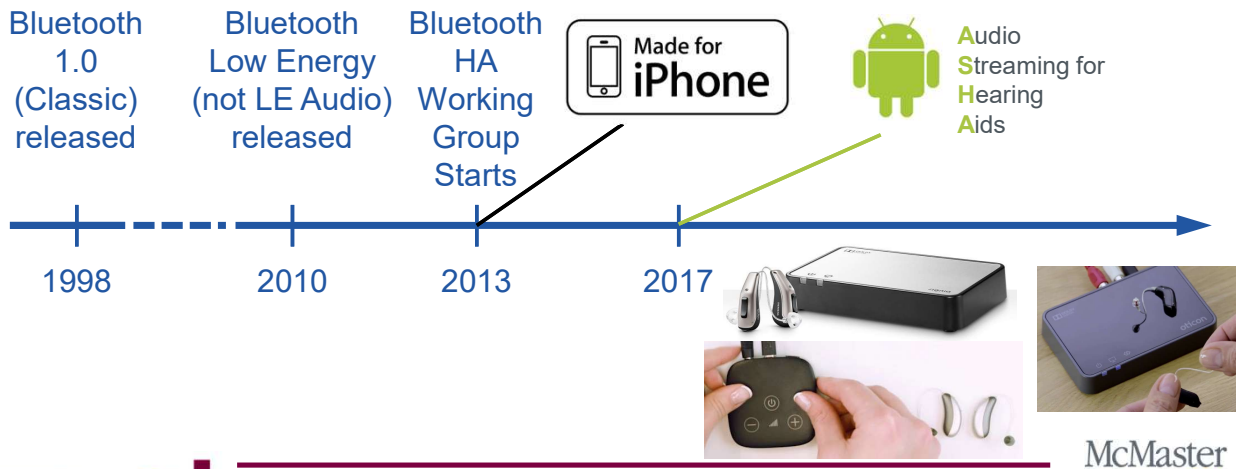


Bluetooth LE Audio development timeline

Comparison of ALS system properties

Property	ALS System Type	
	Telecoil Hearing Loop	*Bluetooth Classic Audio*
Audio Delay	$<$ 1 ms	$\sim$ 100 – 600 ms
Low-Energy (Receiver Side)	Yes	No
Stereo Capable	No	Yes
Broadcast Capable	Yes	No
Simultaneous Streams	No	No

Bluetooth LE Audio development timeline



Comparison of ALS system properties

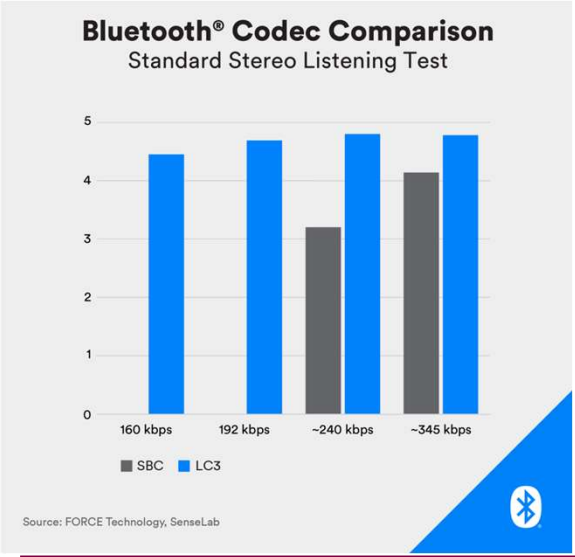
Property	ALS System Type		
	Telecoil Hearing Loop	*Bluetooth Classic Audio*	*Proprietary 2.4 GHz*
Audio Delay	< 1 ms	$\sim 100 - 600$ ms	$\sim 25 - 50$ ms
Low-Energy (Receiver Side)	Yes	No	Yes
Stereo Capable	No	Yes	Yes
Broadcast Capable	Yes	No	Yes
Simultaneous Streams	No	No	No

Bluetooth LE Audio development timeline

Comparison of ALS system properties

Property	ALS System Type			
	Telecoil Hearing Loop	*Bluetooth Classic Audio*	*Proprietary 2.4 GHz*	*Bluetooth LE Audio*
Audio Delay	$<$ 1 ms	$\sim$ 100 – 600 ms	$\sim$ 25 – 50 ms	$\sim$ 25 – 40 ms
Low-Energy (Receiver Side)	Yes	No	Yes	Yes
Stereo Capable	No	Yes	Yes	Yes
Broadcast Capable	Yes	No	Yes	Yes
Simultaneous Streams	No	No	No	Yes

Bluetooth Classic and LE Audio Sound Quality

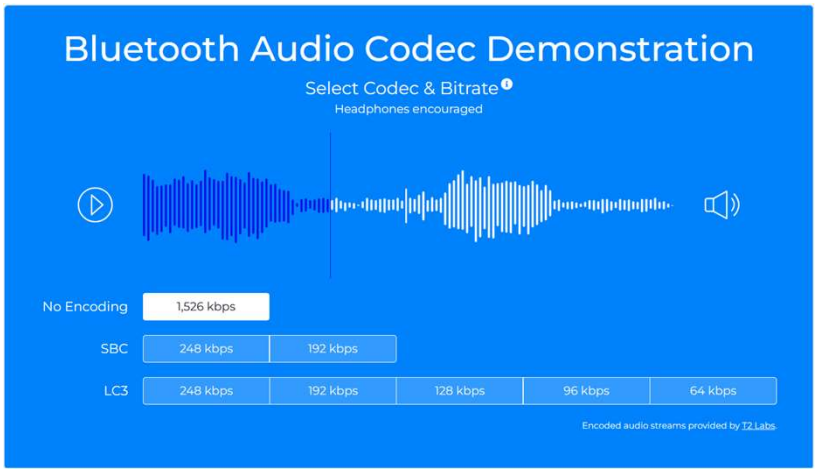


Bluetooth Classic Audio codec:
SBC - Sub Band Coding

Bluetooth LE Audio codec:
LC3 - Low Complexity Communications Codec

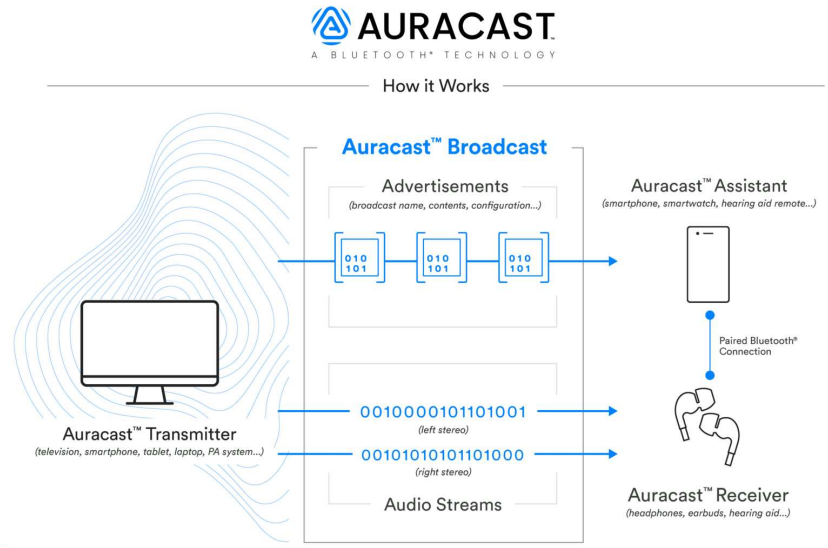
(Bluetooth SIG)

Bluetooth Classic and LE Audio Sound Quality



https://www.bluetooth.com/learn-about-bluetooth/feature-enhancements/le-audio/

Auracast functionality

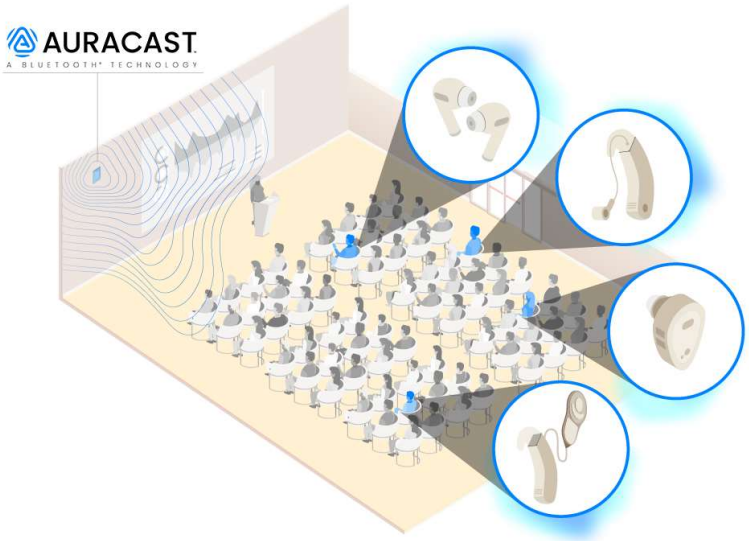


Auracast Assistant

Opportunities

1. Universality
2. Stereo audio with relatively low audio latency
3. Potentially increased range of broadcasting
4. Multiple simultaneous streams (e.g., targeted audio, different languages, different audio mixes for people with hearing difficulties)
5. Expanded usage scenarios

Proposed Auracast usage cases



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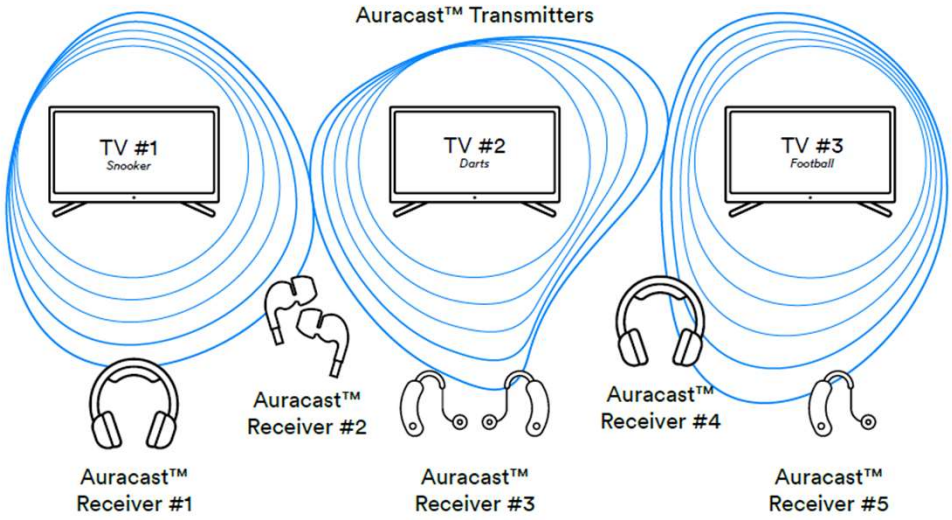


Proposed Auracast usage cases

Challenge #1

AVAILABILITY and UPTAKE

After Bluetooth LE Audio was finalized in November 2022, only one HA company and one consumer AV/smartphone company released compatible products in 2023.

Several other companies are releasing products in 2024, but the rollout is slow.

Large-venue Auracast-based ALS systems are just starting to be released.

Challenge #2

DIVERSE APPROACHES TO ASSISTANTS

Hearing aid, earbud and ALS equipment manufacturers will likely take different approaches to the functionality of their Auracast Assistant apps.

Audiologists will need to be familiar with these diverse approaches and educate clients on the specific functionality of their devices and Assistant app.

Challenge #3

SOUND LEVEL CALIBRATION AND CONTROL

The evaluation and calibration of magnetic induction hearing loops and HA telecoil receivers are covered by national and international standards and are carried out by trained ALS installers.

The Bluetooth SIG has taken the approach of *recommendations* for manufacturers and a “qualification” process for manufacturers to be able to claim Auracast compatibility.

Potential solutions to sound level control

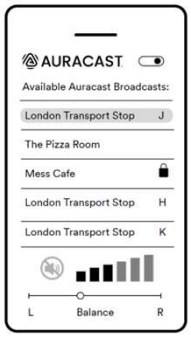
LEVEL METERS ON TRANSMITTERS?

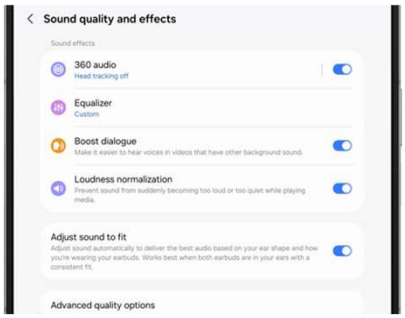
FM Transmitter

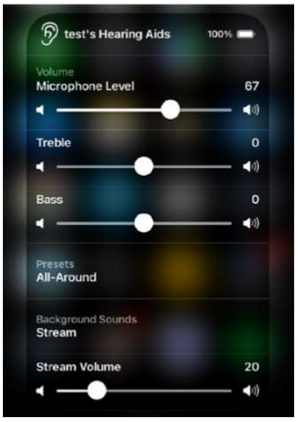
Auracast Transmitters

Potential solutions to sound level control

USER CONTROL?

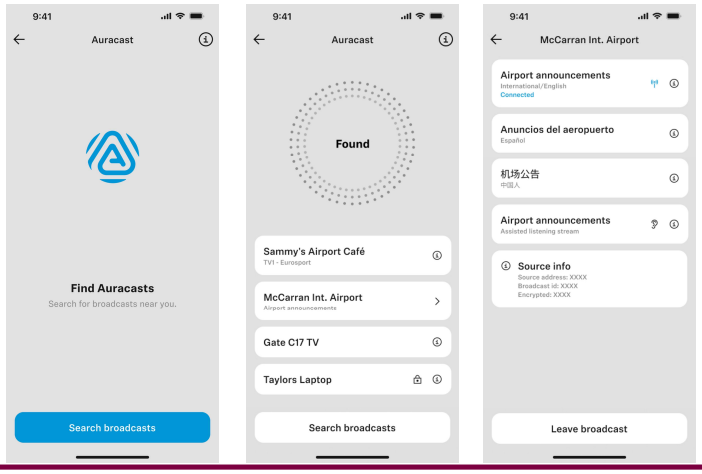






Potential solutions to sound level control

LEVEL METERS ON ASSISTANTS?



Challenge #4

VENUE COVERAGE

Hearing loops and IR systems are typically set up for a limited number of sections of a large venue.

Bluetooth LE Audio has better range than Classic Audio in most scenarios, but RF repeaters may be required for full coverage in large venues.

However, regulations will differ across countries as to the maximum RF power that is permissible.

Challenge #5

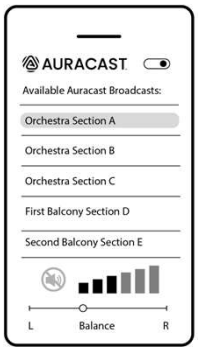
ACOUSTIC DELAY MATCHING

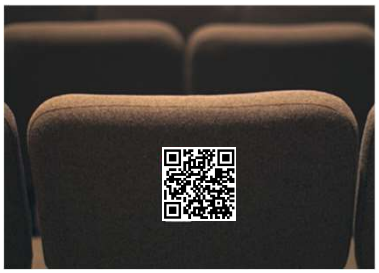
In large venues, the signal delay in hearing loops and IR systems can be matched to the acoustic delay in the section where users are seated.

The longer and somewhat variable delay in Auracast transmitter-receiver pairs and the potential for users to sit anywhere in a venue make this acoustic delay matching more problematic.

Potential solutions to acoustic delay matching

DIFFERENT DELAYED STREAMS FOR DIFFERENT SEATING SECTIONS?





Potential solutions to acoustic delay matching

TIME-DELAY ESTIMATION BY
THE SMARTPHONE ASSISTANT APP?

Challenge #6

WHAT TO INCLUDE IN THE AUDIO MIX

For large venues with live or recorded music, is it sufficient to stream just speech/vocals, or should a complete sound mix be streamed?

And if the latter, then should this be the same as the PA speaker mix, or should the mix be optimized for listeners with hearing difficulties?

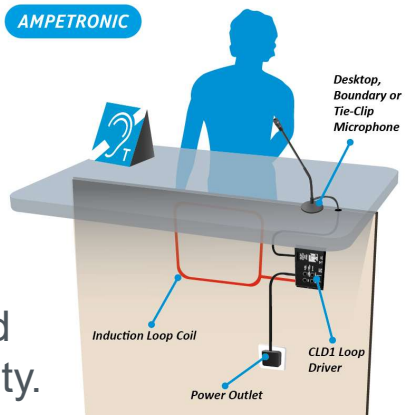
Challenge #7

PRIVACY

Small hearing loops at service counters provide good privacy.

Encrypted Auracast streams provide privacy only if a new encryption code is generated for each new conversation.

Specialized Auracast transmitters will need to be designed with appropriate functionality.



Thanks!

Questions?

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