# Wireless Technology in Hearing Aids

**Presenter: Eric Branda, PhD, AuD**

Hello. Thank you, everybody, for joining. My name is Eric Branda and I'm with Signia. And yeah, we're going to talk about wireless technology and hearing aids today. Just to advance a couple slides here.

Risks and benefits and learning outcomes. These will be in your handouts with the wireless technology. I just think this is a fascinating area of hearing aids. This is something that, you know, when I got into hearing AIDS, you know, 25 some years ago, I didn't realize this would be as integral a part of what we do. And what I'd like to get out of today is just kind of going through an overview of it, some of the differences between different types of wireless technologies to help in looking, how to address it with patients and just have more comfort in wireless because it's grown so much over the past several years.

Quick disclosure. I do work for WS Audiology, for which I receive a salary. And with that, I think the best place to start is at the beginning. And just a quick look at the history of wireless. It's been around since the late 1800s.

If we go back to Marconi and getting into the telegraph system. Here's a guy in Italy, he was trying to get his patent done in Italy. You'll see the patent was actually done in England. They were recommending him for psychiatric evaluations when he was promoting the idea of wireless and trying to push this forward. But obviously it did move forward and he started to make big strides in it.

And I think it's very telling that the first message was, are you ready? Because it's really saying, are you ready? In my mind, are you ready for what wireless does to the world we live in over a century after that came about? And when we think about wireless transmission, the basics of it is you have a transmitter and a receiver. So you're usually finding a frequency that the transmission is going to work on, and the receiver and antenna is going to pick it up in that same frequency you're going to hear a lot today.

2.4 gigahertz. That's a very popular frequency that we work with with transmitting in today's wireless atmosphere. And when we transmit, we've got that signal coming along on the frequencies we have that, say, 2.4 GHz frequency going from the transmitter to the receiver. But encoded on that frequency is all the different information that we're transmitting. So different data points that are going from point A to point B is all on that carrier frequency.

So we're going to dig into that a little bit more. But I like to go into that idea of we've got a frequency, we've got a transmitter that's sending to the receiver that's picking it up on that same frequency. So it's that communication. And those frequencies happen on the ISM radio band. So the industrial, scientific and medical radio bands, these are regulated by the fcc.

They started to be put in place by an organization prior to the FCC. And, and this is where we find things like 2.4 gigahertz, your garage door opener falls on a particular radio frequency. And every time you tune into to the radio in your car. When I listen to my 104.7 classic rock growing up, that was an ism band that I was targeting. So all these different bands have their specific frequencies and there's a few that we work with specifically in our field.

And the two areas that I really want to focus on today are going to be near field magnetic induction and the 2.4 GHz wireless technology. Now there are other wireless technologies on. You've got magnetic induction via telecoil. You have your FM systems that you would find in a classroom or such. Not completely ignoring these, but for today with our time, I want to focus on these two specific wireless approaches.

And the first one of these that I'll talk about is near field magnetic induction and near field magnetic induction. It's a short range and it is near field. And here's where we have just the wireless signal transmit at a very short distance. So it's magnetic field. I've got again my transmitter and my receiver.

And this is usually one hearing aid to another hearing aid. We saw this introduced in hearing AIDS back in 2004. So we've been doing this for over 20 years now. We've been doing this for quite some time. And basically the transmitter coil in one device will modulate a magnetic field and the receiver will pick that up.

And when I say short range, these can go up to 2 meters. And that's getting kind of big for near field magnetic induction. When we work with these in hearing aids, we're really looking at something that's going from ear to ear. We don't need to travel much further than that. And where you heard me mention 2.4 GHz earlier, here we look at something more like 13.56 MHz, a popular carrier frequency.

Again, for example, this frequency would travel from one instrument to the other one. And then all the data that we want to work with would be encoded in that frequency as the data being transmitted.

Due to that Transmission range. We, we usually think of this as how we want to synchronize information between devices. And when I talk about synchronizing information between devices, we're looking at your classification systems, your noise reduction, volume control settings, so all these things that are specific to the hearing aid settings. And we get a really good quality signal transfer because we're working at that lower frequency, that magnetic range there. What it means is that things that are known to block wireless signals in higher frequencies don't affect this frequency.

And this is stuff like water and body tissue. These things can be barriers for other types of wireless transmission. For near field magnetic induction they are not. Which means that majority of what our body is made of does not block the signal. So we have a really efficient way of transmitting information from one device to another without the body blocking it or interfering with it.

And when we start to send that information now each hearing aid can start to process information from the other device.

What I've got diagrammed here is a transmission between two devices. This is looking at what we call bilateral beamforming. If we think directional microphones anymore are beamformers, they're usually unilateral beamformers. Now we're looking at a bilateral beamformer which has each device working with information from the other device. So as you kind of look through the schematic here, if we look at the top, I've got the left hearing aid there and I've got two microphones on there.

And the signals come in from both microphones and we start with monaural processing. But then that signal is sent to the opposite side as well as to where the binaural processing section and the other instruments doing the same thing. So each instrument has four microphones worth of data to process. And because it can do that, not only does it know what the other instruments doing in terms of classification and volume settings, it also knows from that mic input the same types of localization data that we would, the brain would tend to work with. Because now I've got four different points that sound is going to hit a microphone so that we can start to look at where a sound source is coming from.

And this starts to open up a lot of functionality in the devices. When I looked at things like noise reduction and volume controls, those are kind of basic synchronization things with near field magnetic. Now with bilateral beamforming and some other directional aspects, we can start to look at more advanced features, kind of higher tier processing using the same type of wireless transmission those I was talking about with the Narrow directionality that we just looked at that schematic for. For I can take that normal unilateral beam and by combining it with both instruments I can narrow that. So in a low noise situation I don't need a lot of directionality.

But if I get to a higher level noise where we're talking a loud restaurant or a loud crowd situation, and my focus to improve that SNR is to really target my conversation partner. Now I can do that with the bilateral beamformer and that is a function of what we can do with the magnetic induction. And at Signia, with our most recent technology, ix we add in real time conversation enhancement. And now I can start to again using information from both devices, target multiple talkers and get multiple beams so that I can assess where that speaker is located and how loud they're talking and what I need to do to hear talker 1, talker 2 or talker 3 in a multi talker situation. So again, by sharing the information between devices, I can now enhance my conversation abilities.

So I can look at this multi talker situation where before we would have had to just include two talkers in one wide beam. Now I can give them each their own kind of private beam to let me hear them more discreetly and more distinctly. And we can even take that a little further. If I go to CIC or single mic instruments, the wireless transfer helps me do some other directional capabilities there in that to have directionality I need two microphones. On a cic I don't have space for two microphones, but I know the directionality that my pinna creates.

I know the input from Mic 1. If I wirelessly send that over to the other device and I know my input on mic 2 on that device and my pin effect there, I can start to calculate some directional performance because of this wireless processing. So magnetic induction gives us a really efficient way to share this information and enhance what the hearing aid can do in, in these difficult or challenging situations and not even going to everything that's possible, but there's other things where we can use both devices to detect one's own voice or help in cross by cross situations. So there's a lot more we can do with it. And it's a very functional part of what we do with the hearing aid.

So if I look at near field magnetic induction, there's a lot of benefits to it. It's not an expensive type of technology and it's very energy efficient and transmitting efficient because it doesn't have a lot of battery drain. So I can run this constantly and not have any excessive power consumption. So we can still maintain power efficiency. And because it is propagating through body and water, it's not getting stopped by the body.

We can still make sure we get a really reliable signal so that signal can constantly get through and keep itself updated with each other. Now a challenge to near field magnetic induction is it is short range. I mean it is called near field for a reason. And as I said, it's got that kind of 2 meter max which would be like a bubble around the body. And what we do is more like a bubble around the head.

And anything outside of that bubble doesn't get the signal. So that's one challenge in that if I want to look at phone use or other types of longer distance transmissions transmitting from a tv, I would need some type of relay. I would need to use the near field to get to a relay device and then that relay device for farther transmission. So that is a challenge. But because of the design of the near field that also becomes an advantage for us.

So it lets us still work in that device to device reliably. Now I can take a moment here to see if there's any questions which comment. Cross and bycross do not permit localization, but magnetic induction does provide some pinna and body timing difference for that localization. Please comment. So on the cross and bycross.

No, you're not going to have the localization capabilities with the poor ear there. But what we can do is have reliable transmission from the side to side and we can actually skew our directionality to help focus on the better side. So we're using in this case not as much for localization but using the wireless to make sure we have again a reliable transmission of the audio signal from one side to the other. So with the, the basics of what we want to do with a cross or by cross to get that signal from ear one to ear two, it's using magnetic induction is how we're going to transmit that wirelessly. So you're going to have localization difficulties there.

We can skew the directionality when we're indirectional to help focus on the target we need to. But the key point of magnetic induction for cross and bicros will be for transmission of the, the audio signal to the other ear.

So that is going to lead me into 2.4 GHz and 2.4 GHz is something I'm, I'm sure you've all heard it. You've got phones at home that use it Whether it was your old cordless or your cell phone, our, our world pretty much works in 2.4 GHz. But a key thing I like to look at is at 2.4 GHz. Again, we're talking about that ism band. And band is a key word there because it's not just 2.4.

It's not like a pure tone frequency we're working with, but it's 2.4 to 2.4835. We can round it up to 4.84. But you have actually this band of where this is happening in this transmission. This gives us farther transmission than we see with near field. So now we're looking at around 30 to 60ft.

You can see some variability. Walls can be a hindrance. It can get through walls. Think of your WI fi system. Phones and WI fi work on 2.4.

So in some ways it's got further transmission with less barrier. But if I compare it to other signals, there's more barriers there. One barrier for it is water and body tissue. So it doesn't transmit well through those. Which actually is one of the devices I have listed there is microwave ovens.

Microwave ovens are actually the reason 2.4 GHz is our commonly used unlicensed wireless band. Because your microwave oven works on 2.4 GHz. And if we start when they looked at what band to work with, 2.4 was in everybody's houses via microwaves. So that became the band to go to. But if we think about how a microwave oven works, basically those waves heat up the water or fat, and that's how it cooks the food in there.

So we know it's not passing through, it's actually getting stopped by it, which is why the body becomes kind of a baffle or barrier for 2.4 transmission. Some of the features I talked about, like the bilateral beam former, those can be done with the 2.4 GHz wireless. But you have, I would say, less reliability because of possible body interferences. Magnetic induction doesn't have that. But looking at more of what 2.4 does for us today, 2.4 is basically our most common communication frequency that we work with.

And you can kind of visualize it. There's just a lot of lot of signals flying around us all the time on 2.4 GHz. Again, your Wi Fi is working on 2.4 GHz. Probably it could be on 5000, but it's 2.4 is a common one. Your phone is working on 2.4.

And so this is a very common frequency area. And one of the things that helps us keep it from getting too much interference is frequency hopping. I won't spend a lot of time on this, but it's just remember as I'm saying, this is working in a band, not a single frequency. If my transmitter and my receiver both know different frequencies, it can hop from one frequency to another and they can keep up with it. And that data is still being transmitted over it.

That was kind of introduced from Nikola Tesla. Worked with it a bit, but so did actress Hedy Lamarr. Hedy Lamar worked with a composer going to look at how piano keys would work in different frequencies on the keys. And the idea of frequency hopping came to mind as a way to transmit data more securely and keep from anything sitting on one single frequency for too long. And again, if the transmitter and receiver know the pattern, then they can follow each other and still get that data that's encoded in the frequency and that becomes a key to.

The next thing we'll talk about is under the 2.4 GHz is we have Bluetooth and Bluetooth is.

We've known this, it's been around since 1997. And Bluetooth works on 2.4 gigahertz. And it was basically came out to work with things like gaming, printing, audio transmission. So around 1998, we saw the Bluetooth Special Interest Group, the Bluetooth SIG came together and has a lot of membership companies. So as a manufacturer, if you're going to work with Bluetooth, you interact with Bluetooth SIG on what's going on with that.

And again, when I talked about near field magnetic coming into hearing aids in 2004, well, with that we started using a relay to do a Bluetooth transmission to phones so we could have near field magnetic induction from the hearing aids to a neckloop relay. And that relay could have Bluetooth in it. So we could start to see Bluetooth in hearing aids. And that first Bluetooth would be Bluetooth classic. And classic is always a funny word for me on this because it's classic because it has been around for a long time, but it's also a standard and it's a very reliable standard that still gets upgrades.

So I don't want to think of classic like, oh, that's old stuff because there is newer stuff, but it's still a reliable standard. So it's nothing that I ever want to dismiss because it is a reliable standard for us and Bluetooth classic and that's Originally again think about your people transmitting their phones, having the big blue headphones on. But it would allow us to stream to all Bluetooth devices. So a kind of a made for all. Almost every mobile phone supports this protocol.

So it's very common, very easy to find something. Working with Bluetooth allows hands free calling. Biggest problems we've always run into with it are that it's high power consumption that'll suck a battery dry pretty good. Especially when this was first getting introduced in hearing aids. So power consumption has always been an issue.

And then broadcasting, no broadcasting possibility. And I want to break broadcast down to the nature of it. It's casting the signal in a broad manner. Bluetooth is always unicasting one to one. So Bluetooth Classic has always been a one to one as opposed to a broadcasted signal.

So really if we think about Bluetooth Classic, it was not designed for hearing aids, but because of the audio capabilities of it, it's always been interesting for us in hearing aids.

So that led eventually to Bluetooth low energy because again Bluetooth is high energy for everything. It's working with not just audio. Bluetooth low energy came about as a way of transmitting data. It was specified for data now in hearing aid applications that data meant programming devices or control commands from a phone app. So that was where the main involvement came.

And I do have some letters there for some of the different signia devices available that it or that have been available using Bluetooth low energy. But it was never really meant for audio transmission. The lack of a streaming protocol for audio just made it very difficult. So yeah, here we had something that was fast low power, but wasn't doing a lot for our needs in audio transmission. But we had some great news from Bluetooth in 2013.

They talked about low energy protocol for audio streaming. So we got excited. 2013 we started talking about Bluetooth Low Energy with audio. 2014 started talking about Bluetooth low energy with audio. It was coming, it was coming and in 2023 it finally arrived.

So it took 10 years of looking for low energy audio to come.

Some of you might be thinking that, well I've worked with some type of Bluetooth transmission that wasn't classic, but wasn't but was before 2023. And that's where there's a couple other terms that are worth knowing here. Made for iPhone. So Apple got clever in there very soon in 2014 with their made for iPhone audio transmission, which built on the Bluetooth low energy but found a way to do some audio transmission so it'd be Stereo streaming, very low power consumption and fit well in Apple's ecosystem, which Apple's pretty good at making things work nicely within Apple. And then of course that leads to the same problem is that if you're not an Apple user, this wasn't a real option for you.

So here's where you started to have to choose between iPhone made for iPhone or Bluetooth Classic. And depending on what phone your patient had and what they wanted, it could get a bit more challenging. A few years after that we came up with ASHA because we needed another acronym that was identical to an acronym in our industry. But this ASHA stands for Audio Streaming for Hearing Aids. And this was basically the non iPhone application for audio streaming using low energy.

But it's not necessarily an official protocol from Bluetooth. So this low energy streaming of audio and low energy control of the hearing aid, but no hands free calling and very limited availability. So these came out there. And then in 2023 we've seen low energy audio. And with low energy audio this is going to have.

This has very energy efficient streaming, good quality, low latency. And latency is important because Bluetooth itself has a longer latency for just audio phone use. That's fine, but if I'm doing something like watching tv, I can run into lip sync issues. The TV will be faster than the audio because of latency. So here we've got ways to start to speed up that latency.

Hands free calling optimized for hearing aids. There are some broadcast possibilities. The biggest issue we have right now, today, and today is important in anything we do with wireless in that there's still low market penetration. Any new technology takes time to work into the market. Think about TVs when we've had HD or 4K work in, it had to be developed, then you'd had to have some TVs that work with it, signals that would transmit in that way.

And then you also had to be ready to buy it. So unless you're ready to buy the technology with that, you're still waiting until you're ready ready to buy. In that case a new tv. In this case, looking at a device that has LE Audio, your laptop may or may not have it, your phone may or may not have it. There's not as many devices, but we do see LE Audio as the future in that in the next couple years we're going to see 3 billion types of devices with it.

90% of new smartphones will support Le Audio. So it is coming, it is right there, it's here today and it's going to just continually grow. So the penetration of low energy audio is going to keep going. The other alternatives will still need to be there this year where we'll see a lot of overlap on these technologies. So it's all going to be there.

It's just we're going to see that low energy audio continually grow. And I think what also in that there's another aspect of low energy audio that I think is worth mentioning and many of you may have heard the term auracast and Oracast is a Bluetooth technology. If you'd asked about this two years ago or if somebody mentioned it two years ago, you would have probably said what I think it was just about two years ago. So it was the first time I'd heard about it. It's interesting.

It's a form of Bluetooth low energy audio. So basically a subcategory of LE audio. And where we think of Bluetooth is usually a one to one. The idea of oracast is a broadcasted signal and there is some availability of it today. But this is really new.

And if we think about the idea that this would be one signal could be broadcasted to multiple wearers applications might be airports. Having your gate send a Signal to Gate 23 can send a signal. You can use a phone or some device to get your specific gate information. Go into a sports bar and different TVs up there with different games. You could tune into your game that's broadcasting to anybody who wants to listen to TV number three could tune into that.

But this is all really green technology. There's lots of rules still being established for it. There's some rules if we think about assistive listening systems, community venues, music venues, where we use loop systems. Right now we're still using loop systems. Some of the rules for that I don't think are going to be in place till 2027 and then it still has to get rolled out into devices.

So Oracast is coming as part of le, but it is definitely it's a green banana in that regard. And it's not ready for prime time. It's growing for assistive wireless. You're still looking at things like T coil that is going to be there for quite some time. So this is down the road.

But I'd be remiss not to mention that it's there and exists and it's part of a low energy audio. So considering all this, finding the right solution, I mean there are a lot of different wireless options. I think my goal today was to kind of break down what different wireless is out there to understand it. And you want to look at finding the right solution for what your patient has in terms of phone or TV or needs without compromising on audiological performance. If you're looking at solutions from Signia, just this week we introduced the Signia bctix.

This does have Bluetooth Classic built into it. So Bluetooth Classic, we look at that again as something that is very standard. About 99% of phones will support that also. So you can pair with pretty much any device for hands free calling with the devices. It does have an integrated T coil, great battery life, LED charging and then all that power of IX like the multi beam real time conversation enhancement is built into that.

That's the platform of ix. So that's a solution that covers a lot of the wireless bases. Does not have LE audio which is why we have this pure charge and go tix. So here I've got Bluetooth low energy and Bluetooth low energy audio. Think of those people that are more in that iPhone centric group than with new technology.

Because again that's not in all phones. Also has T coil battery life is still great. We want to get more than a day even after the device gets old and all that IX processing with the real time conversation enhancement. So all these devices have that near field magnetic induction reliability as well as one form of Bluetooth for connectivity. So overall, when I look at wireless solutions on the market, wireless is standard in our hearing aids.

It is, it's here. It's not going away. Different protocols will give us different goals for hearing aid performance, whether I want the reliable ear to ear or whether I want to look at the connectivity aspect. So now getting a feel of that helps decide what is the right product for a patient based on what they have and what their needs are. So with that I want to thank everybody for the time and I will take a look at questions.

Eric, thank you so much.