Issue: January 2006

Normal Version

The Future of Wireless Devices in Hearing Care: A technology that promises to transform the hearing industry

by Jerry L. Yanz, PhD

Wireless hearing aids, ALDs, and test equipment open up a whole new world for hearing health care.

Wireless is here to stay and has the potential to significantly affect the provision of hearing care. Hearing aids equipped with wireless systems will solve many of the most common issues encountered by hearing aid wearers, including telephone use, noise, and listening problems associated with distance, reverberation, and dynamic listening environments.

Wireless technology in the broadest sense is not new. Indeed, at the turn of the 20th century, the term "wireless" was one of several words vying for a position in the popular vernacular—among other candidates, such as Hertzian waves, electric waves, ether waves, spark telegraphy, space telegraphy, aerography, and atmography—to describe radio.[1] Today, a century later, we are once again getting excited about the development of an ongoing array of devices that can communicate and interact with one another without wires.

FIGURE 1. The ELI Ear Level Instrument uses Bluetooth wireless technology in conjunction with a hearing aid (left) or a neckloop (right).

This article will offer a brief sampling of current and future wireless technology. The focus will be on devices designed to assist hard-of-hearing people with challenging communication situations and hearing professionals with the tasks of fitting and adjusting hearing instruments. It will also address the possibility that these wireless developments may lead to a convergence of the hard-of-hearing market with the normal-hearing market for consumer electronics.

The New World of Wireless

For a hard-of-hearing person, the basic task of an ancillary communication device— a subcategory of assistive listening devices (ALDs)—is to improve signal level and reduce noise more effectively than hearing aids alone. The goal is to achieve speech comprehension in situations that may otherwise prohibit it, including large group settings, restaurants, and other noisy environments, and on the telephone.

In the 1970s, FM classroom amplification systems replaced older hard-wired systems and freed hearing-impaired kids from their tethers. Since then, a proliferation of analog wireless devices—FM, infrared, and inductive loop—has appeared to address both small and large scale listening applications.[2] Now the digital age is fostering the expansion of wireless capabilities, and devices are improving in performance at the same time they are growing smaller.

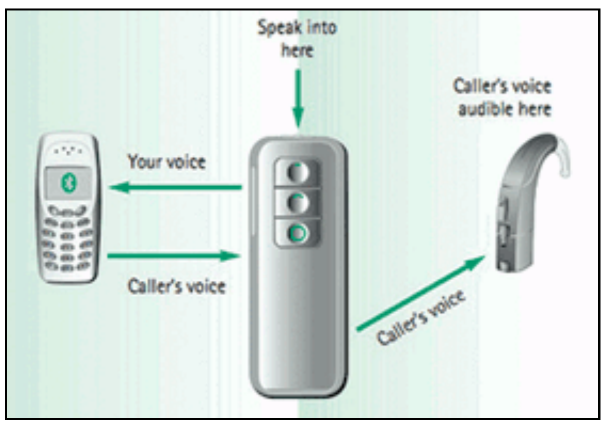


FIGURE 2. The Phonak SmartLink system uses Bluetooth technology to permit interfacing between the hearing aid and cell telephone.

Wireless telephone connectivity to hearing aids. The past year has seen the introduction of two wireless devices to assist hearing aid wearers overcome the frustrations of telephone use. Both the ELI Ear Level Instrument[3,4] (Figure 1) from Starkey Labs and the SmartLink system[5] (Figure 2) from Phonak use Bluetooth technology to deliver a robust signal to the hearing aid. The goal is to alleviate issues of feedback (experienced with acoustic telephone use) and electromagnetic interference from a variety of sources—including the buzz arising from digital mobile phones—which compromised their use by hearing aid wearers. With these two devices, many hearing aid wearers, for the first time, can use the digital mobile phones that have become such a common sight in the hands of people who have no hearing difficulty.

These two products are similar in principle but differ in implementation details. The SmartLink remote module receives a Bluetooth signal from the phone and then sends an analog FM representation of the signal to an FM receiver on boot of the BTE hearing instrument. The ELI module, on the other hand, receives the Bluetooth signal directly from the phone with no intervening analog FM transmission, and sends its output to the hearing instrument directly through a BTE direct audio input (DAI) boot or a specially adapted inductive neck loop. With Bluetooth as the sole transmission modality, the device offers excellent resistance to potential sources of radio-frequency interference.

Scheduled for release just after the first of the year, a new ELI DiRx option will use a directional microphone to improve the signal-to-noise ratio of the outgoing voice of the wearer. And, in early summer 2006, another version to ELI will be released, with a number of important upgrades, including higher signal strength, smaller size, longer battery life, and the ability to switch from one signal source to another with a single button press.

Wireless digital ALDs. Wireless ALDs are not new; analog FM systems have offered this capability for years. Today, however, we are witnessing the development of Bluetooth wireless transmitters as the sending portion of the ALD. Bluetooth transmission and reception can be expected to improve performance and security and reduce radio-frequency interference compared with analog FM systems. Furthermore, these devices will be considerably smaller than their FM predecessors.

One such digital Bluetooth ALD from Sound ID, which includes a transmitter and receiver, was recently released to the market. This system is not designed for use with a hearing aid, but rather uses a stock receiver that hooks over the pinna.

FIGURE 3. The BluePal, slated for release by Starkey Laboratories in spring 2006, is a Bluetooth Wireless Microphone that can be used in conjunction with ELI, SoundPort, or other Bluetooth receivers. Transmitters like BluePal and Sound ID offer the advantage of being attached to companions' clothing and used, for example, in a noisy restaurant.

Another miniature, digital ALD transmitter, called BluePal, is scheduled for release by Starkey Labs in March 2006 (Figure 3). BluePal and the Sound ID transmitter can be attached to clothing, have a microphone that picks up the wearer's voice and a Bluetooth transmitter to transmit that voice, for example, across the table in a noisy restaurant or across the front seat of a retiree's RV to a Bluetooth receiver on the driver's hearing aid. The fact that these devices are small enough to wear like a brooch or carry in a pocket will make them more user-friendly than earlier analog FM devices. In addition, they can pick up the output of a television or radio via their microphone or a direct cable and send it to the Bluetooth receiver.

Bluetooth devices fall into two categories: Class 1 with a range of 100 meters and Class 2 with a range of 10 meters. Most Bluetooth devices, including Sound ID and BluePal, are Class 2, accommodating face-to-face conversations with companions. A future modification of the BluePal transmitter will be designed as a Class 1 Bluetooth device, which with its greater range, can be used effectively even in a large auditorium.

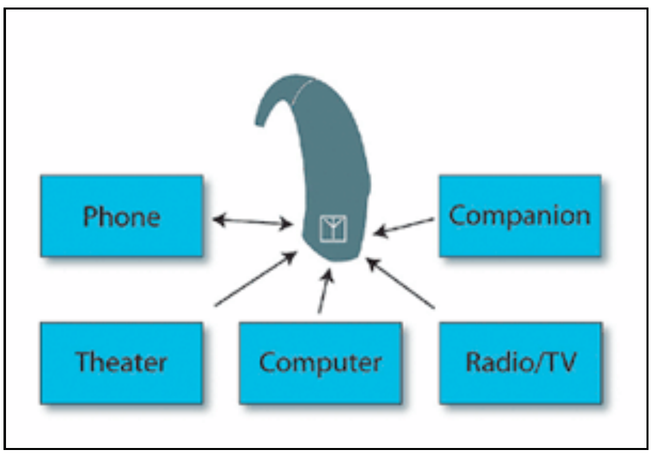


FIGURE 4. Increasingly, audio connections will be expanded to include direct wireless input from the telephone, movie theater sound systems, computers and Internet, media sound sources like TVs and radios, as well as supplemental microphones attached to companions.

Expanding audio connections. In addition to the usual audio sources—like individual's voices and the output of television, radio, and various music sources—new audio sources are also compatible with these wireless receivers (Figure 4). The most obvious is the personal computer, which can store and play back digitized music and also tune in to radio stations that broadcast their programming over the internet. Any Bluetooth-enabled device, including a computer, can send its output to a Bluetooth receiver.

Now let's stretch our imaginations a bit. Millions of people have come to rely on email as a primary means of communication. Amidst the pressure to keep up with correspondence, one might envision the development of a text-to-speech converter that would translate email into synthetic speech. We could then listen to email through a discreet wireless connection, instead of reading it.

Group applications. Bluetooth was designed initially as a point-to-point transmission—that is, from one sender to one receiver. However, a point-to-multipoint Bluetooth profile has been developed, which may be used in future audio applications. This design will accommodate multiple receivers, though not an unlimited number, in auditoriums, theaters, and classrooms, and yet will not be subject to the issues of crosstalk, interference, and lack of security suffered by current FM group amplification systems.

To improve the auditory experience even more, recently designed stereo Bluetooth profiles will begin to replace the monaural profiles currently in use.

Getting rid of the outboard parts. The ELI and SmartLink instruments, which are designed specifically for use with hearing aids, still require components outside the hearing aid, and as an industry we are always aware of the push for things to be smaller and less conspicuous. Some wireless systems already exist in CICs, such as the Siemens Acuris, and additional work is under way to develop a wider array of wireless applications that fit completely inside a hearing instrument case.

The feasibility of a very small receiver depends in part on having a design that doesn't require much power, and the proximity of transmitter and receiver minimizes power demands. Therefore, in early implementations of in-the-aid wireless systems, a relay (eg, transmitter box) in close proximity to the hearing aid may receive the wireless signal from its source and relay it to the receiver in the hearing aid. At some point, in-the-aid wireless options may come available that do not require a relay, but instead link the signal directly from transmitter to receiver.

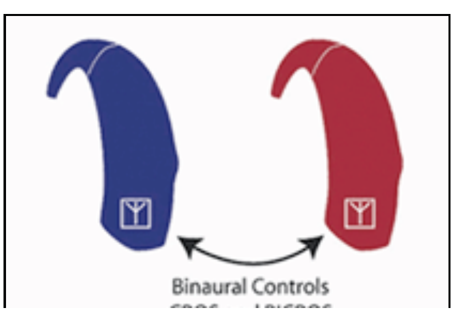
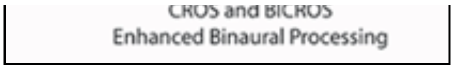


FIGURE 5. Wireless binaural integration in hearing aids will progress from wireless controls and synchronization functions to new CROS and BICROS applications, to even higher levels of enhanced binaural signal processing.

Wireless binaural transmission. Devices currently on the market (Siemens Acuris) allow one to adjust hearing aid volume or memories on both sides by manipulating a control on only one side. Binaural wireless connectivity—that is from one hearing aid to the other—has the potential to improve hearing aid performance beyond the task of manipulating controls (Figure 5). Newer digital transmission modes,[6] for example, will likely replace older wireless CROS and BICROS fittings and will likely be feasible in even the smallest instruments.

Also, we have known for many years that two ears are better than one. It appears likely that we will be



able to convey signals back and forth between the ears and apply algorithms that enhance binaural processing, improving audibility and intelligibility of the speech signal.

Wireless programming. Hanging somewhere in all audiologists' and hearing instrument specialists' offices are myriads of programming cords to accommodate the non-standardized 2-, 3-, 4- and 5-pin programming connectors used in the hearing aid industry today. On July 12 1994, the Technical Committee of the Hearing Industries Association (HIA) met in Minneapolis to address the possibility of creating a universal standard for a programming cable to connect from computer to hearing aid. The vision was to have one interchangeable cable for all manufacturers' instruments. Although the 12 companies in attendance agreed on the goal, it was never achieved. Now we have the possibility again—this time in the form of wireless connectivity.

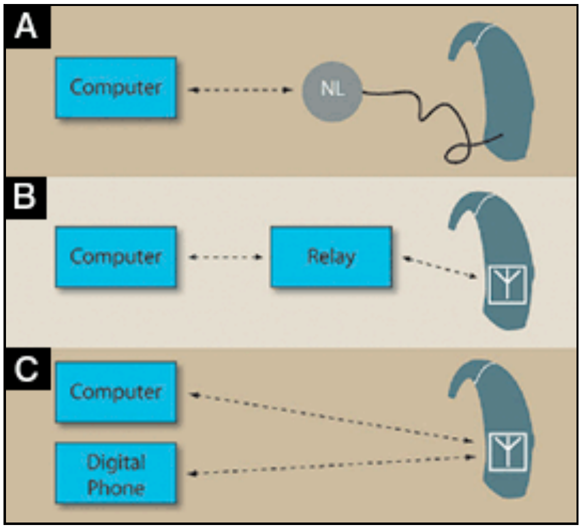


FIGURE 6. Hearing aid wireless programming may progress from the current system of using a computer that transmits Bluetooth data to the NoahLink medallion device (NL, 6a), to a system that eliminates all wires (6b). Ultimately, it is entirely possible that wireless programming can take place without a relay via a digital telephone in addition to a computer (6c).

Completely wireless programming of hearing instruments is within our reach. NoahLink has taken us part way to that goal, with a wireless Bluetooth connection between the computer and the NoahLink medallion (Figure 6a). However, this system still requires wires from the NoahLink medallion to the hearing aids.

It would be logical in the next phase of development to eliminate the wires to the hearing instruments. Such a system will require a programming receiver that is fully contained inside the hearing aid, plus a relay to convey commands between the computer and the hearing aid (Figure 6b). And, perhaps someday soon, wireless programming may be achieved without the relay and with control signals coming not only from a computer, but also from a digital telephone (Figure 6c).

A wireless experience monitor. Data logging is becoming available in a growing number of hearing instruments. It may someday become standard to have an external digital device that monitors acoustic experiences that a hearing aid wearer encounters and stores this information for later retrieval by the dispensing professional to assist in programming adjustments.

The hearing aid market is beginning to see what we might call "experience monitors" (eg, Oticon Envirometer[7]), small devices carried in a pocket or pinned to clothing, which track the acoustic situations that a wearer encounters. It is conceivable that the same monitor could periodically signal through the hearing aid that a test is about to take place. It would then present a paired comparison of two hearing aid program settings, and the wearer would register his/her preference by pressing a button on the monitor. Over time, the hearing aid, assisted by the monitor, "learns" what settings and what algorithms the wearer prefers in various acoustic environments. Eventually, the hearing aid processor would learn enough that it could perform all of the operations without the user/monitor's input, and the monitor could then be discarded or returned to the dispensing professional.

Where is wireless ultimately going? Clearly this is an exciting time for the hearing industry. Wireless developments have the potential to change the products we are providing to our patients and even the ways in which those products are provided. Engineers in the hearing aid industry are collaborating with engineers in other technologies to lead us along this promising path. The products just described are likely to be realized within the next two to three years.

Convergent Technologies and theMainstreaming of Hearing Care

These wireless technologies may play an additional role in altering the nature of hearing care, with the potential to merge the hard-of-hearing and the normal-hearing marketplace into one market addressing the hearing care needs of both groups. The number of normal-hearing people using audio devices is rapidly increasing, with wireless earphones to handle calls from their digital mobile phones. Those same receivers might be used to pick up the voice of a friend in a noisy restaurant or bar, or to hear a radio broadcast from the computer without disturbing others.

As more and more people use wireless technology, the distinction between having a device on your ear to deal with hearing impairment and having a device on your ear to enhance auditory experiences may become blurred. We see two people wearing gadgets in their ears; who knows if one gadget has more gain than the other? As this distinction blurs, the age-old stigma that has dissuaded many people from using hearing aids may disappear.

FIGURE 7. The SoundPort from Starkey Laboratories is an example of a Bluetooth receiver that uses a custom earmold but is designed for normal-hearing people. The positive impact on hearing aid stigma of this class of products is promising, as the line between "hearing device" and "communication device" becomes further blurred.

The Bluetooth receivers discussed earlier, such as ELI and SmartLink, for use with hearing aids may help spark this market convergence. While we are fitting wireless assistive devices to our patient, the patient's family or friend may wonder if such a device might be available for them. In fact, a product currently being sold by Starkey Labs, called SoundPort, is a Bluetooth receiver for normal-hearing people, but one that uses a custom earmold (Figure 7).

With the promise of better comfort, retention, and sound quality, the SoundPort earset requires an ear impression to make the custom mold, a task that naturally falls to the hearing professional. Congratulations. By accommodating the needs of patient and family at the same time, you have just converted your hearing aid dispensing office/practice into an Ear Store, serving both hard-of-hearing and normal-hearing clienteles. And, as you establish your reputation in the normal-hearing market, when those normal-hearing customers begin to consider hearing aids, your office will be the place to go.

Bluetooth versus proprietary technologies. One variable that will affect the potential for convergence in the market is compatibility between the wireless device in a person's hearing aids and the devices with which the hearing aids might communicate. Bluetooth is a set of standards to which any designer can adhere to ensure compatibility between his/her device and others on the market. For example, any receiver that uses the Bluetooth Headset profile can accept a signal from a transmitter that uses that same profile. Since it is a rapidly evolving technology, scores of companies are designing products to Bluetooth specifications. A developer in one specialty area can conceivably harvest the ability of his/her device to talk to others.

Conversely, proprietary wireless designs may offer specific capabilities that other products cannot achieve. Yet their development will likely be slower than a development that relies on an open standard, and the cost of development and of the ensuing product will be higher. Furthermore, they will not be able to take advantage of evolving technologies in related fields as readily as Bluetooth developers.

This balance between proprietary and open products will most likely affect the buying decisions of hearing care professionals as they begin using the products. Some will want the exclusive advanced features of proprietary designs, while others will be attracted to cross-product compatibility, the ability of one device to work equally well with many others and the potential for expansion into the normal-hearing market.

Summary

Wireless is here to stay and has the potential to significantly affect the provision of hearing care. Hearing aids equipped with wireless systems will solve many of the most common issues encountered by hearing aid wearers—telephone use, noise, and listening problems associated with distance and reverberation. They may also someday enhance binaural processing and offer a means by which a hearing aid can learn how best to deal with the ever changing acoustic environment. Ultimately, wireless devices may foster the convergence of the normal-hearing and hard-of-hearing markets and potentially redefine the way hearing care is provided. It's an exciting time; stay tuned.

Jerry L. Yanz, PhD, is a senior trainer in the education and training department at Starkey Laboratories, Eden Prairie, Minn.

Acknowledgments

The author thanks his colleagues David Preves, Randall Roberts, and Jorge Sanguino for their expertise and contributions to the development of this article.

References

1. White TH. United States early radio history. Available at: http://earlyradiohistory.us/sec001.htm.   Accessed: December 19, 2005.
2. Hearing Loss Web. Available at: http://www.hearinglossweb.com/Technology/ALDs/alds.htm. Accessed December 19, 2005.
3. Yanz JL, Roberts, R, Sanguino, J. A wearable Bluetooth device for hard of hearing people. The Hearing Review. 2005;12(5):38-41
4. Yanz JL. Phones and hearing instruments: Issues, resolutions and a new alternative. Hear Jour. 2005;58(10):41-48.
5. Tchorz J. Utilizing Bluetooth for better speech understanding over the cell phone. The Hearing Review. 2005;12(2):50-80.
6. Rogers Scholl J. Using WiFi technology for children with unilateral hearing loss. The Hearing Review. 2005;12(5):44-46.
7. Flynn M. Envirograms: Bringing greater utility to datalogging. The Hearing Review. 2005;12(12):32-38.

Correspondence can be addressed to HR or Jerry L. Yanz, Starkey Laboratories Inc, 6600 Washington Ave South, Eden Prairie, MN 55344; email: jerry_yanz@starkey.com.

Normal Version