

## Bluetooth Technology – Part I

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Wireless connection between a hearing aid and another sound-emitting/communicating device has long been a goal of hearing aid design. This has been achieved using radio frequency, electro-magnetic induction, and infrared systems. The most recent, and perhaps the most promising approach to expand wireless communication, and with hands-free operation, is the use of Bluetooth technology. Bluetooth technology has been around since 1999 and has been of interest to those designing hearing aids for quite some time. Primary limitations at this time are that Bluetooth operation requires a greater amount of power than the hearing aid can provide, and Bluetooth profiles for operation with hearing aids would have to then be developed. (A greater in-depth thesis on Bluetooth Technology can be found at <http://hearinghealthmatters.org/waynesworld/2013/bluetooth-101-part/>).

It seems to be that the logical goal relating Bluetooth technology to hearing aids is to have the hearing aids function as wireless headsets. This would be directed, most likely, to the interaction with smart phones, which would allow those with hearing loss to talk on their phones with greater ease, and without annoying acoustic feedback. Other Bluetooth-enabled devices, such as MP3 players, PCs, radios, televisions, and landline telephones could also then connect wirelessly to the hearing aid. Such connections currently exist using Bluetooth to an intermediary gateway device.

This Bluetooth editorial series will concentrate primarily on Bluetooth technology and what would need to be involved in communicating between the hearing aid and a remote device, without a gateway device between them. In other words, a system that allows the devices to “talk” directly with each other. This does not describe any existing systems.

### What is Bluetooth?

Bluetooth is a technology for exchanging data wirelessly over *short distances* from fixed or mobile devices through personal area networks (PANs) (Figure 1). Bluetooth is built into an untold number of products, from cars and mobile phones to medical devices. It allows the sharing of voice, data, music, photos, videos, and other information wirelessly between paired devices. It differs from other radio technologies (mobile phones, radio, and television), in that it uses radio waves to transmit over a much shorter distance (10 meters or less) as would be needed for hearing aids. Up to eight devices can be connected,



Figure 1. Personal area network (PAN) set up using Bluetooth technology. This shows a host

consisting of a “host” and seven “slaves”.

Devices are connected under Bluetooth using radio frequencies in the global 2.4 GHz (2400–2483.5 MHz) Industrial, Scientific, and Medical (ISM) band. Bluetooth was originally designed to replace cables that connected devices. In the hearing aid discipline, the early notable example was its use to replace the Serial port, RS232, cable connection between the programming computer and the HiPRO box. The Noahlink interface uses Bluetooth technology to go cable free.

(PC) and four slaves (smart phone, headset, scanner, and keyboard). For speculation, any or all of these could be hearing aids with the ability to communicate with each other. A maximum of eight devices are possible, but all must be within the transmission range, and they must be “paired” with each other to communicate. (With permission of Hearing Health and Technology Matters).

## What is So Great About Bluetooth?

Bluetooth is a unique wireless technology intended to realize the following three objectives:

1. Eliminate the connection of wires associated with most consumer and computer equipment, and to do this without any direct action from the user,
2. Allow multiple devices to be connected at the same time, and to function as an intelligent whole (to “talk” to each other), and
3. Make a location centric connectivity seamless (devices automatically find each other and discover what they can do for each other).

Bluetooth is a standards-based technology (IEEE 802.15.1 ) that can be utilized by computers, digital cameras, mobile phones, etc., to allow these activities to occur.

Other wireless systems operate in the 2.4 GHz band as well. An example is Wi-Fi IEEE 802.11, which is used for connections over a much longer distance. To achieve this great distance, Wi-Fi requires higher power when compared to Bluetooth. The 900 MHz ISM band has been used as well, but is only available in the Americas, making it an undesirable choice for broad international use.

How would Bluetooth differ from other wireless systems used with hearing aids such as infrared, RF (radio frequency), or magnetic induction? Bluetooth can allow combined use of functions by multiple devices, rather than just a one-way transfer of signal between a transmitter and receiving device. In Bluetooth, the “connected” devices in the PAN automatically find each other, establish connections among themselves, and essentially “talk” with each other to discover what they can do in common. In other words, Bluetooth provides two-way (or, up to eight-way maximum) communication, depending on how many devices are in play. Each device has a transceiver (combination of transmitter and receiver).

## Under the Bluetooth 4.0 (and 4.1) Umbrella

The latest versions of the Bluetooth standard support 3 protocols, Classic (as used by Noahlink, and audio streaming devices such as wireless speakers), High Speed (not useful in the Hearing Aid context), and Low Energy (the maintainers of this standard prefer we use the word “Smart” instead). The key feature of Bluetooth Low Energy (BLE) is implied in its name. It is a protocol having a low power consumption that makes it possible to power a small device with a small coin cell. In our field this has potential to be used for very low data rate things like Remote Control of Volume and Program settings. Bluetooth LE lowers current consumption by putting the radio in sleep mode most of the time and efficiently reconnecting on wake up. This keeps the average

power consumption to a minimum. However, as data rates are increased, the radio spends less time sleeping. If we want to stream audio, the energy savings provided by the Smart protocol are expected to be minimal compared to the Classic protocol. Expected was written because the Smart (Low Energy) protocol does not have a profile for sending Audio! Bluetooth Smart Ready devices can via software freely flip between any of the protocols supported. The option selected will depend on the desired function.

Expect more about Bluetooth versus Hearing Aids in the next issue.