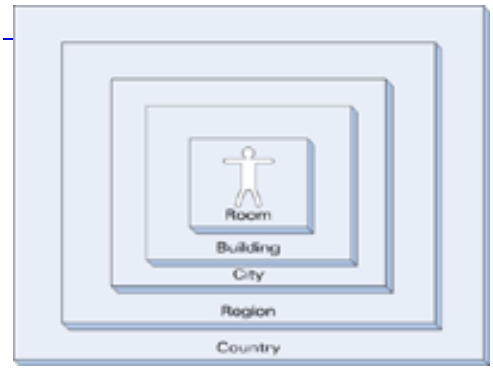
Bluetooth & UWB – A Future of Unlimited Possibilities

By Tom Siep

Bluetooth&reg and Ultra-Wideband-enabled devices offer enhanced capabilities that will make possible new applications and change the way people collect information.

There are many ways to exchange information between personal devices. Cell phones, laptops, PDAs, MP3 players and desktop computers all have increasingly large



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amounts of data to transfer. Normally, a single technology is used between any two devices at any one time. Previously it was wires, but increasingly there are a number of wireless options such as Wi-Fi, Bluetooth&reg or proprietary schemes. In the future, very fast and efficient movement of data will be facilitated by a combination of Bluetooth and the new Ultra-Wideband (UWB) technology. Bluetooth brings an established, accepted technology for low power connectivity, while UWB provides an extremely fast data transfer rate, enabling new applications requiring large but brief wireless transfers, such as downloading video.

UWB &#151 One of the Future Wireless Technologies We all know there are many kinds of wireless communications in use today. As users find themselves in situations and/or using different applications, they will choose the particular flavor of communications that meets their needs. The IEEE1 divides the wireless world into five classes based on the coverage:

&#149 Wireless Personal Area Networks (WPANs)
&#149 Wireless Local Area Networks (WLANs)
&#149 Wireless Metropolitan Area Networks (WMANs)
&#149 Wireless Regional Area Networks (WRANs)
&#149 Wireless Global Area Networks (WGANs)

These coverage classes are shown in a graphic representation in Figure 1. WPANs typically cover 10 meters or less, WLANs generally transmit at 10 times the power

and cover about 100 meters in ideal situations. WMANs are also about an order of magnitude larger than its predecessor. The WRANs and WGANs are each about two orders of magnitude larger than the next smaller footprint technology. All of these technologies are evolving and each has an expanded role for endusers in the future. The technology that will change most radically is in the WPAN arena. The engine of that change will be the introduction of UWB capability. UWB has the potential to radically alter how individuals gather and save information that is directly under their control.

UWB wireless communications technology sends data using high frequency, low-energy pulses. It differs from other wireless technologies by achieving communication at transmit levels below the noise floor &#151 sophisticated receivers in UWB radios detect signals at levels below normal background interference. For users, UWB offers incredibly low power and high speed, and supports hundreds of simultaneous channels. It attains very high data rates of up to 400 Mb/s in a scaleable architecture. In addition, it offers the potential of very good coexistence with other wireless technology because UWB signals do not interfere with each other or with conventional RF carriers, and the UWB signals are difficult to detect beyond the range of the WPAN technology.

Current WPAN Leader: Bluetooth Technology

The dominant WPAN today is Bluetooth technology. It is estimated by the Bluetooth Special Interest Group (SIG)that there will be nearly a billion Bluetooth-enabled devices deployed by the end of 2006 &#151 and the rate of adoption is increasing.

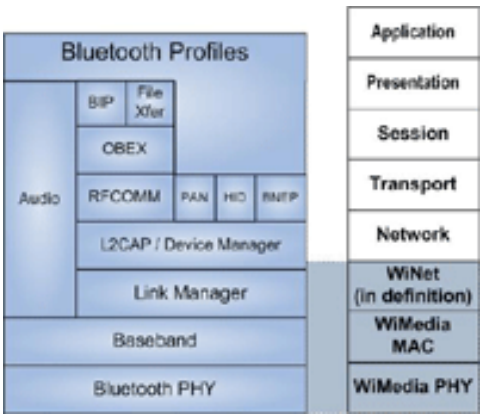
The initial use of Bluetooth technology was for audio applications, such as mobile phone headsets, where it excels because of its inherent low power consumption. However, the communications protocol was designed for much broader applications. Figure 2 shows the stack as it compares with the ISO OSI stack. Although there are significant differences in the layering and structure, the lower layers of the Bluetooth technology and the ISO-oriented example are similar. In this example, the WiMedia UWB technology shows it does not currently extend beyond the lowest layers.

The speed of the Bluetooth technology is fairly slow by today’s standards. Wi-Fi and 802.11 are developing standards that will allow that technology to reach in excess of 120 Mb/s. Today, a current Bluetooth device will go is fast as 3 Mb/s. This is appropriate for audio streaming, but not nearly enough for heavy data-oriented applications like video.

Why Not Abandon Bluetooth?

If Bluetooth devices are very slow communicators, does it make sense to continue to use the technology? The answer is yes, for two reasons: low power and application profiles (applications).

Profiles provide interoperability and a huge advantage for Bluetooth developers. Product developers can use a common set of application-specific facilities to wirelessly



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interact with other manufacturer's products and achieve a high degree of interoperability very quickly. The larger the pool of interoperating devices, the more attractive it is for developers and end users alike. Profiles are largely absent from other technologies, including those being developed in WiMedia.

Although application profiles are a straightforward advantage for Bluetooth, power consumption is a bit harder to explain. Both technologies claim low power &#151 and both are, in their own way.

In terms of absolute power consumption, Bluetooth Radios consume much less power when transmitting. UWB radios, however, transmit their data so much faster that the difference is more than made up for by the decreased length of time the radio needs to be on. This seems to give the UWB the edge.

However, there is yet another power cost factor that gives Bluetooth the advantage. In WPANs, most of the time is spent staying connected, waiting and listening for data to be sent or received. For UWB radios, this time is expensive in power consumption, which tips the balance back over to the Bluetooth side.

Bluetooth Alliance with WiMedia

Rather than abandoning the existing Bluetooth technology, the Bluetooth SIG is now in the process of adopting the WiMedia UWB as an alternate physical medium. The combining of the two technologies will result in better power savings than either one alone could provide, and gives WiMedia a much-needed application base.

One approach is that Bluetooth technology is being developed to be a control channel that establishes application connections using its low-power association mechanisms, and then turns on and off the UWB only when a device needs to send a large amount of data.

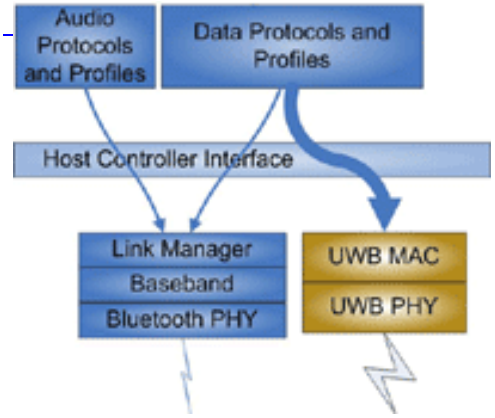
The details of how they will work together are still being pursued. Broadly, the steps are:

1. Bluetooth establishes the connection at the physical layer.
2. Capability of a common UWB facility is discovered and reported to upper layers.
3. Both low and high speed channels are set up.

4. Service discovery in Bluetooth determines if a requested end-user function (or application) can be performed.
5. Bluetooth profiles define the applications' data paths &#151 or alternately &#151 a mechanism independent of application figures out best data path.
6. UWB is used as a high speed pipe, which is turned on when needed and turned off when not power-cost effective.
7. Low speed Bluetooth links maintain the connection between devices for as long as needed

Looking at the protocol stacks in Figure 3, the data paths are slightly different depending on application needs. Current audio applications, such as mobile phone headsets, do not need the speed of UWB and remain in their current technology. The data path is shown with two arrows: a thin one for low data rate applications and a thick one for the newer high-data-volume uses. In all cases, the packets that provide command and control information go over the Bluetooth connection.

Bluetooth's UWB Deployment
Bluetooth technology is one of the most successful personal data communications tools in history. Devices that have the combination of Bluetooth and UWB will step into



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an existing market place that will quickly appreciate the enhanced capabilities. The combination will make possible new applications such as streaming personal video, advanced wireless sound systems, personal TV broadcasting and wireless portable mass storage.

The first UWB consumer devices will likely be proprietary WiMedia-only implementations that precede the completion of the mutual protocol work being done in the Bluetooth SIG and the WiMedia Alliance. These may be seen as early as the first quarter 2007.

Initial Bluetooth implementations will have a limited number of UWB bands, hosted in advanced high-end mobile phones much later in 2007. Along with these, there will be optional Bluetooth UWB add-ons for PCs. Subsequent devices, fully integrated with Bluetooth and UWB technology, will supply the ease of use, power saving and interoperability expected for consumer devices. This will allow them to provide instant storage and retrieval for all the information that users produce and

consume.

Complementary Technologies
Although one can initially assume that Bluetooth and UWB are competitors, the welding of these two wireless technologies provide more utility than either one could separately. It will change the way people interact with the information world. It will also enhance the flow of the information, which multiplies its utility &#151 making both the technology and the people who use it much more efficient.

About the Author
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In the future, very fast and efficient movement of data will be facilitated by a combination of Bluetooth and the new Ultra Wide Band technology.

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