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How Bluetooth and 802.11 will team up to deliver high speed wireless connections

By Dr. Michael Foley, Bluetooth SIG 05.13.2008  0

Thanks in part to the success of [Bluetooth](#) technology and other successful standards, consumers are increasingly comfortable with using data wirelessly, from two-way phone conversation to streaming stereo audio to swapping photos and mobile phone wallpapers.

Bluetooth technology has helped make this possible, and the Bluetooth profiles that enable sharing of entertainment data are well-established. But usage of these profiles and implementation of hardware and [software](#) support for these use cases are currently hindered by the perception that the data transfer speed Bluetooth technology currently offers is insufficient for these scenarios.

For example, while Bluetooth technology can easily handle the transfer of a single file, consumers would like the flexibility to share more than just one photo or one song, instead sharing the whole album or a vacation's worth of pictures and video.

The Bluetooth SIG and manufacturers have devised a solution already inside a growing number of portable devices: the [802.11](#) radio built into portable devices for [Wireless LAN](#) connectivity.

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With Bluetooth and 802.11 radios already sitting next to each other in so many mobile device—not to mention PC—a solution is ready with an established radio technology that boasts global regulatory approval and a data rate more than adequate for sharing all kinds of entertainment data.

Generic AMP: Using the best radio for the job

At the heart of Bluetooth high speed technology is the concept of the Generic Alternate MAC/PHY (Generic AMP), an innovative formula for radio substitution that allows the Bluetooth stack to dynamically select the right radio for any job.

The Generic AMP enables Bluetooth profiles and protocols to take advantage of higher data rates using one or more alternate high speed radio technologies. Figure 1 illustrates the generic AMP principle.

[Click here for Figure 1.](#)

Figure 1: The generic AMP is a key feature of the Bluetooth SIG's performance roadmap.

The AMP modifies the standard Bluetooth Core architecture to enable multiple alternate radios under the L2CAP layer, with the standard Bluetooth radio (denoted BR/EDR, for Basic Rate or Extended Data Rate of 1 or 3 Mbps, respectively) used for discovery and connection setup and association.

Bluetooth 802.11 AMP supports the ratified 802.11 standards

Bluetooth technology's standards for interoperability require that we select the 802.11 standards that have been fully tested and ratified for inclusion in Bluetooth 802.11 AMP specification.

For this reason, the Bluetooth 802.11 AMP explicitly supports the ratified standards 802.11a, b, and g, all of which are proven and reliable and offer data rates more than adequate for the entertainment-centric use cases manufacturers and customers are demanding now: 24 Mbps as standard and 12 Mbps with a simultaneous SCO connection.

To ensure that all devices using the 802.11 AMP will interoperate, and to guarantee a high data rate across all devices, support for 802.11g is mandatory. Further, the SIG plans to aggressively pursue the inclusion of 802.11n in the 802.11 AMP specification upon ratification of 802.11n by the IEEE.

Bluetooth UWB and 802.11 roadmap

In parallel to the development of the 802.11 AMP, key Bluetooth SIG member companies are hard at work on the Ultra Wideband AMP, which uses the WiMedia UWB radio.

The UWB AMP promises even higher data rates sufficient to stream high-definition video, and it fits in the Bluetooth technology roadmap as the highest-speed Bluetooth physical radio conceived to date.

The 802.11 and UWB AMPs complement each other, with the 802.11 AMP supporting data transfer applications with a radio technology available today, and the UWB AMP supporting high-definition streaming using the radio that will set the standard for short-range connectivity in the years to come.

Seamless and transparent to the consumer

Customers already associate Bluetooth technology with a simple and reliable user experience

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Bluetooth security and pairing are already trusted and familiar, and the Bluetooth v2.1 products reaching the market now are setting a new standard for ease of use with innovations such as Simple Pairing that significantly reduce the input needed to securely pair devices.

The same high standard of ease of use applies to Bluetooth high speed technology, whose operation can and must be seamless and transparent to the consumer. Accordingly, the specification calls for no additional user interaction to select high speed data transmission.

The Bluetooth stack will recognize the need for fast transfer of a large amount of data and automatically assign the 802.11 AMP to the task. When the transfer is completed and high speed is no longer required, the 802.11 radio will be shut down, and the standard Bluetooth radio will activate to maintain the Bluetooth connection.

Messaging the consumer

The Bluetooth SIG's development of multiple high speed as well as ultra low power radio channels means more alphabet soup for engineers, but the SIG and members agree that none of this additional complexity should reach the end user.

Communicating a product's Bluetooth high speed capability to consumers will be done via the already-established Experience Icons, additions to the regular Bluetooth logo that are already in use by leading Bluetooth manufacturers that denote which use cases a device supports.

The SIG has developed an appropriate high-speed icon for the 802.11 AMP that will make the device's capability clear and unmistakable to the consumer.

Bluetooth 802.11 AMP use cases

Already popular among younger owners of Bluetooth mobile devices who share content with their friends, this use case is currently served by the "Send via Bluetooth" function already implemented on many mobile phones, PCs and PDAs. The scenario's appeal grows with the addition of the 802.11 high speed channel reducing file transfer times by a factor of ten or more.

Along with demand for easier image sharing comes the demand for convenient printing from both digital cameras and camera phones to a personal printer or photo kiosk.

Bluetooth technology currently supports printing photos from most camera phones and a handful of digital cameras, but this capability would see more widespread use if the transfer time were reduced. Feedback from consumer printing manufacturers suggests a consumer expectation of three seconds to transfer an 8 megapixel camera image to a printer or printing kiosk.

This translates to an 8-14 Mbit/sec transfer rate to meet the 3 second requirement well within the capability of Bluetooth high speed technology using the 802.11 AMP.

The speed of a standard Bluetooth link renders synchronization between mobile devices and PCs relatively slow when images and large files are included. As with the sharing and printing scenarios, the sync scenario gains attractiveness with increased transfer speed.

We are now beginning to see the emergence of wireless-enabled portable music players with Bluetooth technology to stream audio to wireless headphones, while the 802.11 radio itself has made its way into some players as well.

While standard Bluetooth technology is ideal for audio streaming, Bluetooth high speed technology offers a compelling scenario for loading new songs onto a music player. Bluetooth device discovery and pairing are ideal for ad-hoc connections to another music player, a PC, or a store

kiosk, and the 802.11 AMP lets users add a new album's worth of music in an acceptable timeframe of 60 seconds or less.

There are good reasons to believe that easy content sharing from portable devices such as music or media players and mobile phones to stationary devices such as PCs, set-top boxes, and TVs can have a very bright future if Bluetooth wireless technology is integrated into home entertainment systems.

For example, consider a mobile phone and set-top box both equipped with Bluetooth high speed technology. Bluetooth technology lets the user select and send video files up to movie length for viewing on-the-go with the portable device, with the 802.11 AMP providing a reasonable transfer time of 5 to 6 minutes or less.

Where is the Wi-Fi name?

802.11 is the IEEE numeric code for a wireless LAN specification which is broadly known as Wi-Fi. The Wi-Fi Alliance conducts tests to demonstrate Wi-Fi interoperability and it owns the marks Wi-Fi and Wi-Fi certified.

It is likely that manufacturers will make use of 802.11 technology that is Wi-Fi certified, but not necessary for Bluetooth over 802.11.

In the planned Bluetooth high speed scenarios, the interoperability, profiles and security will be handled by the Bluetooth architecture. However, if the 802.11 radio in a device will also be used for local area networking, interoperability and security protections for those use cases will only have been demonstrated to be in place if the product is Wi-Fi certified.

Bluetooth high speed technology over 802.11 lets Bluetooth profiles run at a higher data rate. It is not intended to replace traditional Wi-Fi use cases, nor will it replace today's Bluetooth technology in the use cases where the current radio delivers better performance.

For the ad-hoc sharing, printing, and sync of entertainment data, Bluetooth technology brings to the table Interoperable profiles that work right out-of-the-box across vendors, operating systems, and product categories.

For connecting devices within the personal area network, Bluetooth technology offers a breadth of supported products and use cases, plus a rigorous standard of interoperability, all of which are unmatched by any other wireless technology.

Bluetooth technology offers another advantage to makers of portable devices: backwards compatibility with the 2 billion Bluetooth devices shipped to date thanks to the legacy BR/EDR radio.

In fact, most of the Bluetooth profiles and use cases will continue to use the BR/EDR Bluetooth radio, as the data rate is more than sufficient for audio, HID, and other common tasks.

The Generic AMP architecture switches to the high speed radio only when needed for transmitting large bursts of data, while continuing to take advantage of the power efficiency of the BR/EDR Bluetooth radio for routine tasks such as discovery, connection, and link maintenance.

Simultaneous WLAN and Bluetooth connections

An essential component of the 802.11 AMP specification is the ability to maintain a link to a wireless LAN access point before, during, and after using the 802.11 radio as a Bluetooth high speed channel. The 802.11 AMP specification guarantees a satisfactory level of throughput for both applications simultaneously.

What the Bluetooth 802.11 AMP means for implementers

Bluetooth high speed technology over 802.11 offers benefits for all types of consumer electronics, with power savings and increased speed especially advantageous for mobile devices.

The competition to deliver the best mobile phone to the carrier and to the end user has turned into a competition to offer the most capable and elegant media experience. Part phone, part camera, part **MP3** player and part email platform, today's mobile devices are portable media hubs that continually push the bounds of hardware design.

We all are familiar with the tradeoffs and frustrations involved in meeting the consumers' and carriers' demands: cramming more **processing** power and wireless connectivity into a smaller package while struggling to maintain sufficient battery life.

Wireless connectivity has also reached standalone devices such as MP3 players and cameras which, just like mobile phones, are now expected to connect wirelessly to both PCs and a growing range of peripherals from printers to headphones.

For manufacturers of devices that currently feature 802.11, using the 802.11 AMP delivers the benefits of Bluetooth high speed use cases while requiring minimal redesign of your products' 802.11 architecture.

In many cases, a software upgrade is all that is needed. For products earlier in the design stage, integrated Bluetooth chipsets and ICs free precious real estate within devices, save power and reduce overall cost.

With high speed Bluetooth over 802.11, manufacturers of printers, cameras, and other products can enjoy all the advantages of Bluetooth technology□ease of implementation using standard profiles and a proven qualification program□while satisfying consumers with the speed of 802.11.

As a result, the projected growth rates of devices that integrate Bluetooth, Wi-Fi and FM radio are impressive. Figure 2 shows market research firm ABI research's forecast for devices with both Bluetooth and 802.11 radios built in.

[Click here for Figure 2.](#)

Figure 2: ABI Research forecasts strong growth for Bluetooth connections .

Conclusion

For OEMs, the Bluetooth 802.11 AMP delivers a means to offer a dramatically improved user experience with an absolute minimum of redesign. Bluetooth high speed technology over 802.11 uses established and reliable technology, and enhances capability and while saving real estate and power□both key selling points for mobile devices.

From the SIG perspective, the decision to pursue 802.11 as a high speed Bluetooth channel is the logical answer to a clear market need. It simply makes sense to use technology available now to deliver what the market needs now

For the SIG, the Generic AMP and the roadmap with the 802.11 and UWB AMPs means keeping an eye to the future, keeping Bluetooth technology innovative and relevant, and addressing the needs of today's consumers in a timely manner. In short, it means following through on what our members and manufacturers expect and rely on us to do.

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Dr. Michael Foley is the Executive Director for the Bluetooth Special Interest Group (SIG). He joined the SIG in March 2004 as the Executive Director. He is responsible for guiding the qualification and interoperability programs, promotion of the technology, the specification publications, and the long-term roadmap of Bluetooth wireless technology. Dr. Foley previously worked with Bluetooth wireless technology and other **WPAN** and WLAN technologies as a senior wireless architect with Microsoft.

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