USB – Can the Greatest Consumer Standard be Overcome?

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Executive Summary

This article will detail USB 2.0 features and benefits, will compare these to Ultra Wide Band (UWB), also dubbed USB 3.0. A head-to-head technical discussion of speed, protocols, industry support, standardization, availability of technology, price, power, promise of future development of technology will all be highlighted as we compare today's greatest connectivity standard with the technology promised to be it's replacement.

Introduction

I know that when I connect my digital camera to my PC over USB, it is going to work. It is going to connect every time. In fact, I personally have a wireless router, printer, digital camera, Blackberry phone, and iPOD that all connect over USB – and they connect successfully every time. So when companies promise me that a Wireless USB solution is coming and that it will be better than USB, I have to wonder. In the USA, there is a saying "don't fix what ain't broke". If wired USB works so successfully, why fix it? With more than 2 billion USB enabled products in the market today already, this Wireless USB standard had better be amazing. Is it? It had better make things easier. Will it? It had better be easy. Will it be?

Although not often referred to as "USB 3.0" in the news or in articles, Wireless USB (WUSB) really is the next generation of USB protocol. In fact, expectations are that traditional USB ports will begin to decrease in coming years as more Wireless USB nodes appear. InStat analysis states "We expect the Certified Wireless USB market to begin in 2006 with significant growth in 2007 and 2008. Overall, we anticipate the shipment of Wireless-USB enabled products will grow 193% annually from 2006 to 2009." Realistically, WUSB node potential is huge, with an estimated 11 million nodes in 2007 growing to over 300 million nodes by the year 2010 according to market research presented at the Certified WUSB developer's conference by Jeff Ravencraft, the president and chairman of the USB Implementer's Forum. The claim is that Wireless USB, a natural extension of USB, could make it even easier to connect peripherals and consumer electronic devices to a host PC. Understandably, the application space for WUSB is exactly the same as that of USB: consumer PC peripherals and consumer electronic devices.

Unfortunately, there is still some market confusion on what Wireless USB really is. Is Wireless USB "Certified Wireless USB", WirelessUSB™, or CableFree™ USB? The answer is that it is all three.

Certified Wireless USB is the only wireless USB standard endorsed by the USB Implementer's Forum, the group that owns the USB standard. It runs at 480MBits / second up to 3 meters from the host. 480MBits / second is exactly the same speed as high-speed USB. Special drivers are required for Certified Wireless USB: Microsoft has alpha versions available now. Certified Wireless USB chips are being demonstrated now, but no products are available yet. The target market for Certified Wireless USB is nominally all USB devices, but the focus seems to be on virtual docking stations where a laptop would be able to "dock" to several peripherals on a desktop without attaching any cables.

Figure 1. Certified Wireless USB Logo

WirelessUSB™ is Cypress Semiconductor's line of low-power, 1MBit/second USB interface products that operate in the 2.4 GHz ISM band with a range from 10 meters (at max 1 Mbit/s) to 50 meters (at max 62.5 kbit/s) and use the existing USB driver infrastructure: no special drivers are needed. WirelessUSB™ products have been shipping for several years from vendors such as Logitech and IBM and are marketed mainly in HID devices (keyboards, mice and game controllers) and audio devices

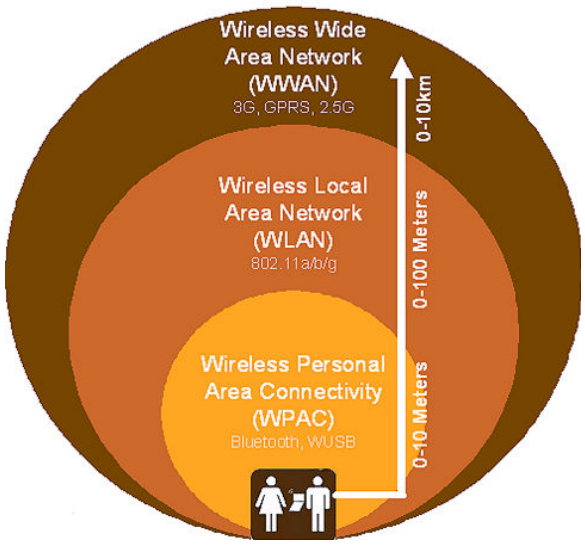
such as VOIP headsets. WirelessUSB™ devices are much lower cost and lower power than Certified Wireless USB or CableFree USB.

CableFree USB is Freescale's proprietary Ultra Wide Band (UWB) standard. CableFree USB runs at 114MBits/second at 10 meters. CableFree USB allows range/speed tradeoffs between 114MBits / second and 28.5MBits / second. Freescale is starting to call CableFree USB "Zero Install" Wireless USB to emphasize that it does not need any additional drivers. CableFree chips are available now and products have been announced for June 2006, but none are shipping yet. The first CableFree USB products are "dongles" for PC side connection and USB hubs for the device-side connection.

Since Certified Wireless USB is the choice of the USB I/F and most of the large players in the industry, we will look at Certified Wireless USB (CWUSB) in a little more detail. The CWUSB standard has been designed with some very successful standards "cousins" that have established a high level of expectations from consumers: USB and Bluetooth, the most successful wired and wireless peripheral standards ever. As a result, Certified Wireless USB has been designed with high bandwidth, low cost, low power consumption, and physical size requirements all in mind for serving next-generation consumer electronic devices. CWUSB device applications could include:

- Moving audio files to and from an MP3 player to in-home storage devices
- Phone to phone communication and downloading
- Downloading from video camcorder to PC for editing, then to TV for viewing
- PDA's synchronizing data to PC
- Loading games and audio/video files to PDA
- Connecting laptop to game console
- HDTV to/from PVR and STB, store and (re)play streaming AV
- Audio/Video server or Media PC to DVD player, PVR's, HDTV, hand held appliances
- DVD or Audio/Video server to headset
- PC data to printer and other legacy USB devices
- …wherever a USB cable exists today…

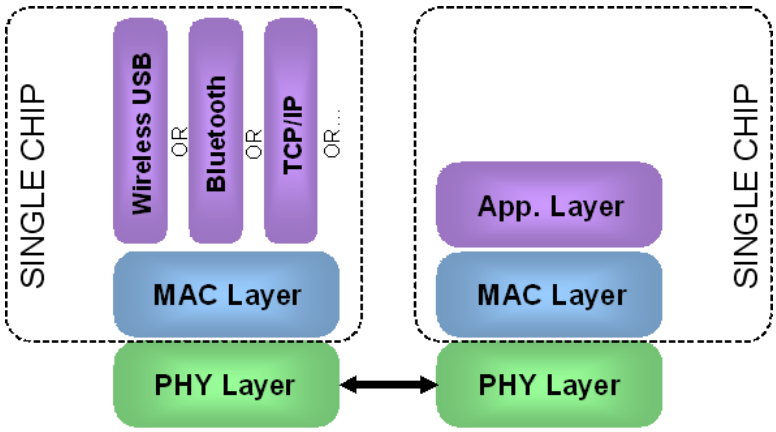
Figure 2. Wireless Standard Application Space



In order to utilize the best of both worlds, wired and wireless, and to emulate the ease-of-use of both of these technologies, developers have had to overcome significant technical hurdles. As with many standards developments, two competing camps emerged. In the case of CWUSB, they are: direct-sequence (DSSS - also used in CDMA cell phones and 802.11b) UWB effort headed by Freescale and the multiband orthogonal frequency-division multiplexing (OFDM – also used in 802.11a and g, ADSL, and DVB) effort supported by the WiMedia Alliance. Both use the United States' 3.1- to 10.6-GHz UWB band, but they use the spectrum in significantly different ways. The direct-sequence (DS) method codes the data and then uses the more traditional pulsed UWB methods. The OFDM method uses standard DSP OFDM distributed in three 528-MHz wide bands over the 3168- to 4752-MHz range. At this point, it seems that the UWB Forum has lost almost all of its battles and that the OFDM method supported by WiMedia has gained international momentum. The USB I/F has chosen WiMedia's OFDM, as has the Bluetooth SIG. While the IEEE standards body in charge of UWB will not settle on either standard, its European counterpart (ECMA) has chosen WiMedia.

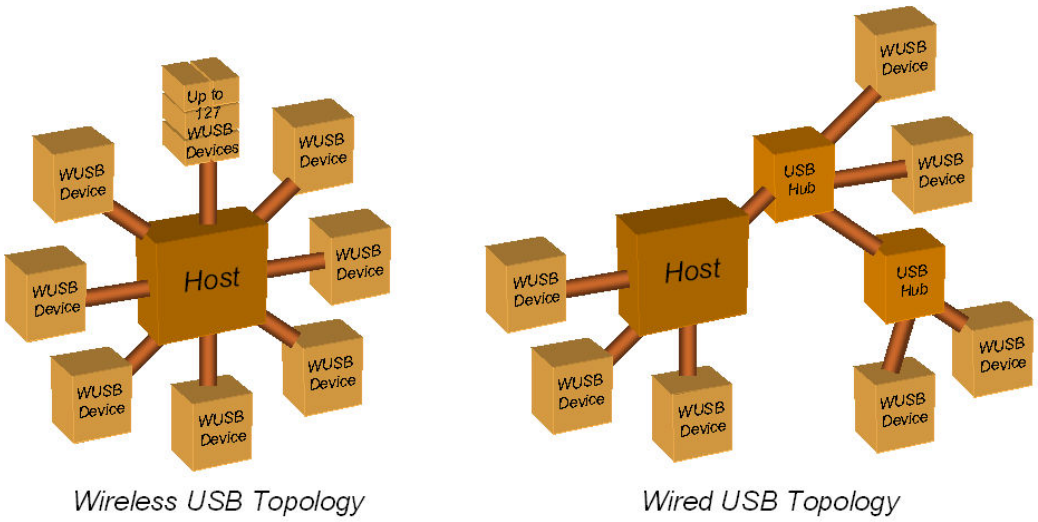
One of the main reasons that WiMedia's standard is winning the protocol battles is interoperability. The WiMedia Media Access Controller (MAC) was designed so that it could support multiple protocols sharing the same frequency spectrum. It does this by forming superframes that are 65ms long, each divided into 256 slots called Media Access Slots (MAS). These time slots are divided between different users that may be using different protocols such as Certified Wireless USB, Bluetooth or TCP/IP (Internet traffic) so that they can coexist without interference. It is this common PHY and MAC layers that allow multiple protocols such as Certified Wireless USB, Wireless 1394, TCP/IP, Bluetooth®, Ethernet, DVI and HDMI to reside on top of the WiMedia UWB platform.

Figure 3. Protocol Stack for Wireless WiMedia Based System



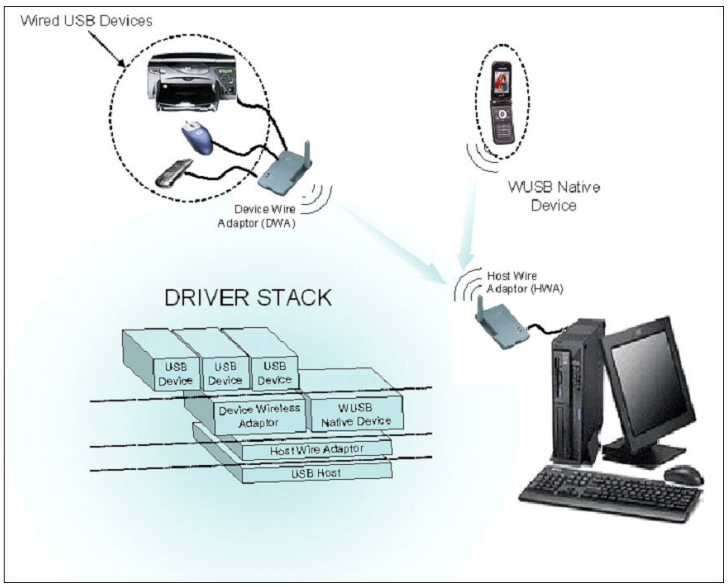
Experienced USB designers will be happy to know that Wireless USB uses the same "host and device" topology as wired USB. Each network cluster has one host (master device) and up to 127 device peripherals (slaves). The concept of a USB hub does not exist in the wireless world, since the radio can transmit and receive from any device directly.

Figure 4. Topology Comparison between Wireless and Wired USB Systems



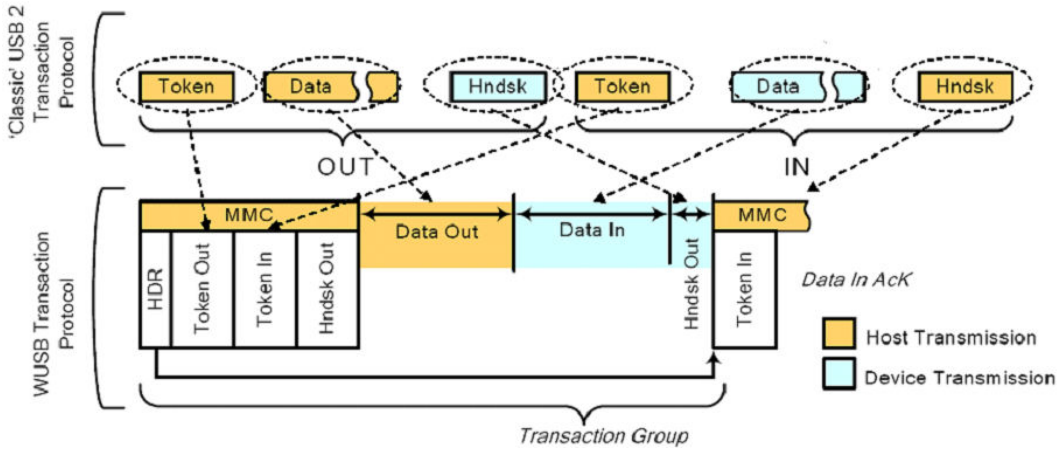
Just like in wired systems, devices cannot communicate with one another in the absence of a host. To overcome this obstacle, and to allow “peer-to-peer” communication, Certified Wireless USB utilizes "dual-role" devices that offer limited host as well as device capabilities. From this topology example, it is also obvious that Certified Wireless USB does not have a need for hub support. Because the host can directly connect and control 127 devices itself, there is no “tier” structure like in a traditional USB system. Initially, however, the industry will need to make way for the slow conversion of the 2 billion devices already deployed in the world. They will do this through development of “Device Wireless Adaptors” and “Host Wireless Adaptors” which are essentially hardware dongles that use the traditional USB port but create a wireless “hub” for traditionally wired USB devices. In the future, these devices will become obsolete in favor of natively enabled CWUSB peripherals.

Figure 5. Hardware and Software Stack for Wireless USB System with Wired USB Devices Connected.



Additionally, the USB communication protocol itself is very similar. As with USB, CWUSB is a packet based TDMA protocol. The Host controller initiates all data transfers. Also, Wireless USB transfers consist of a 'token, 'data', and 'handshake' sequence (see figure 6). One significant difference, however, is that Wireless USB combines several different token information packets into a single packet in order to increase efficiency. Also like wired USB, Wireless USB takes advantage of a 'pipe' structure. This structure creates "endpoints' that are the basis of connection between a device and a host.

Figure 6. "Traditional" and "Wireless" USB protocol Comparisons



The protocol similarities between USB and Wireless USB allow companies to take advantage of existing USB infrastructure and intellectual property. As engineering labor costs are often the most significant develop costs for any system, reducing learning and protocol complexity is key.

While CWUSB still suffers from limitations such as the inability to provide power over cabling like the traditional USB systems, a higher cost for silicon, radio, and device complexity, and an install base of more than 2 billion devices to try to connect, CWUSB does have a lot going for it. With standardized PHY and MAC layers, application drivers being supported and written by Microsoft, device manufacturer's learning from a decade of USB and Bluetooth protocol development, and an innate consumer demand for eliminating wires, Wireless USB is bound to meet projected expectations.

Conclusion

While there are many wireless protocols demanding consumer attention, industry experts cannot deny the momentum of WiMedia's implementation of Ultra Wide Band as a next generation High Speed USB link. Though consumers love the simplicity of USB, they will equally love the transportability and connectivity of devices once they are natively enabled with CWUSB devices. Until then, your briefcase will remain cluttered with cables destined for the trash heap.

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