Ultrawideband:
High-speed, short-range technology with far-reaching effects

MBOA-SIG White Paper
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UWB White Paper

Executive Summary

The ecosystem supporting the development of Ultrawideband (UWB) wireless technology envisions bold solutions to address the new mandates of a "point and click" world. Each UWB-enabled device will cost effectively be capable of automatically discovering and securely communicating with every other device within its environment. This technology represents an innovative revolution designed to meet the requirements of a plethora of 21st century multimedia applications. Seamless connectivity and rapid transfer of data, without confusing cables and wires for various interfaces that will not and cannot talk to each other, is a compelling proposition for a broad market representing hundreds of millions of end users. According to Parks Associates, the market for UWB chips and gear will top $1 billion by 2008.

Although it began as a military application dating from the 1960s, UWB has been redefined as a high data rate (480+ Mbps), short-range (up to 20 meters) technology that specifically addresses emerging applications in the consumer electronics, personal computing and mobile device markets. When compared to other existing and nascent technologies capable of providing wireless connectivity, the performance benefits of UWB are compelling. For example, transferring a 1 Gbyte file full of vacation pictures from a digital camera to a photo kiosk would take merely seconds with UWB compared to hours using other currently available, lower speed technologies (i.e. Bluetooth) and consume far less battery power in doing so.

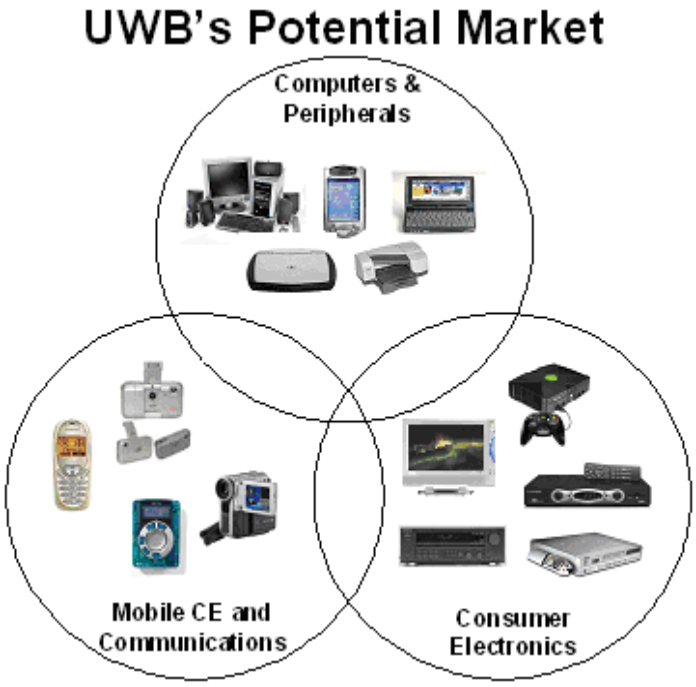


Figure 1

The convergence of data, entertainment and mobile communications within the home has created the need for merging many disparate devices into a single network architecture capable of seamlessly supporting and integrating each sector's unique requirements. To that end, industry consortia such as the Digital Living Network Alliance (DLNA) and the WiMedia Alliance are establishing design guidelines and standards to ensure interoperability. Wireless 1394, Wireless USB, and native IP-based applications are currently under development based on the UWB radio and WiMedia Convergence Platform.

Initial UWB-based products are expected to be introduced in 2005, and it is widely expected that substantial volumes will find their way into consumer applications by 2006. Dozens of semiconductor and consumer product companies are aggressively developing products in a race to win the market.

Under the auspices of the MultiBand OFDM Alliance (MBOA), nearly all prominent providers of silicon and end products for consumer electronics, personal computers and mobile devices have endorsed an evolutionary approach called MultiBand Orthogonal Frequency Division Multiplexing (MB-OFDM) as the optimal UWB solution. While many factors were taken under consideration during the selection process, one of the highest priorities was to ensure the critical goal of global adoption of UWB technology. MB-OFDM has demonstrated several technical advantages, particularly spectral flexibility which will accommodate anticipated differences in spectrum allocations from regulatory bodies around the world, including the International Telecommunication Union.

This document provides an overview of MB-OFDM technology as the de facto standard, as well as the status of MBOA standards development and regulatory issues. It also addresses potential markets and applications, explains the respective roles of various standards organizations and industry alignment within the UWB ecosystem, and reviews relative comparisons with other technologies.

Technology Overview

The origins of UWB technology stem from work begun in 1962 that was generally referred to as impulse radio, baseband or carrier-free communications. The term “ultrawideband” was first coined by the U.S. Department of Defense in 1989, and early applications leveraged the technology’s properties as ground-penetrating radar.

Today, the definition for ultrawideband, according to the FCC, is any radio technology with a spectrum that occupies greater than 20 percent of the center frequency or a minimum of 500MHz. Recognizing the advantages of new products that could incorporate this technology to benefit public safety, enterprise and consumer applications, in 2002 the FCC allocated unlicensed radio spectrum from 3.1 GHz to 10.6 GHz expressly for these purposes. Additional spectrum is also available for use by medical, scientific, law enforcement, fire and rescue organizations.

Rather than requiring a UWB radio to use the entire 7.5 GHz band to transmit information, or even a substantive portion of it, the FCC defined a specific minimum bandwidth of 500 MHz at a -10dB level. This minimum bandwidth (in conjunction with other requirements of the FCC ruling) would substantially protect incumbent users of the spectrum. The flexibility provided by the FCC ruling greatly expands the design options for UWB communication systems. Designers are free to use a combination of sub-bands within the spectrum to optimize system performance, power consumption and design complexity. UWB systems can still maintain the same low transmit power as if they were using the entire bandwidth by interleaving the symbols across these sub-bands.

Given this option for a multi-band system, information can either be transmitted by the traditional pulse-based single carrier method or by more advanced multi-carrier techniques. Pulse-based single-carrier systems transmit signals by modulating the phase of a very narrow pulse. While this is a proven technology that only requires a very simple transmitter design, several inherent disadvantages exist. It is difficult to collect enough signal energy in a typical usage environment (with many reflecting surfaces) using a single RF chain; switching time requirements can be very stringent at both the transmitter and receiver; the receiver signal processing is very sensitive to group delay variations introduced by analog front-end components; and, spectral resources are potentially wasted in order to avoid narrowband interference.

In contrast, MB-OFDM transmits data simultaneously over multiple carriers spaced apart at precise frequencies. Fast Fourier Transform algorithms provide nearly 100 percent efficiency in capturing energy in a multi-path environment, while only slightly increasing transmitter complexity. Beneficial attributes of MB-OFDM include high spectral flexibility and resiliency to RF interference and multi-path effects. It is notable that OFDM modulation techniques have been successfully applied to several other high-performance, popular commercial communications systems including Wi-Fi 802.11a/g, WiMAX 802.16a, HomePlug, and the global ADSL standards.

Based on existing CMOS technology geometries, use of the spectrum from 3.1GHz to 4.8GHz is considered optimal for initial deployments. Limiting the upper bound also avoids interference with the U-NII band where 802.11a resides as well as simplifies the design of the radio and analog front end circuitry. The frequency band from 3.1 GHz to 4.8 GHz is sufficient for three sub-bands of 500 MHz, as illustrated in **Figure 2.**

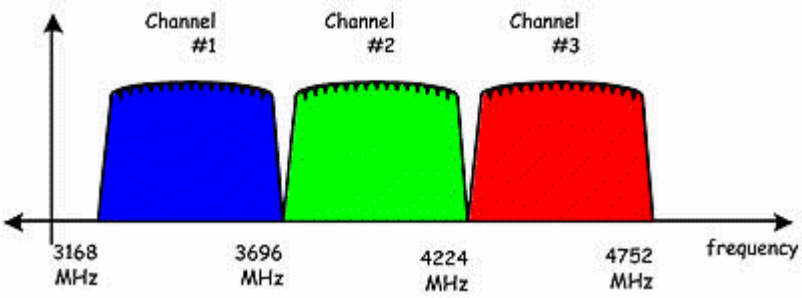


Figure 2: Frequency allocation of sub-bands for a multi-band OFDM system.

Spectral Flexibility

Given the unlicensed nature of the UWB spectrum, all wireless devices sharing the spectrum must coexist. Regardless of present or future spectral allocations and emissions restrictions in various regions of the world, MB-OFDM is capable of complying with local regulations by dynamically turning off certain tones or channels in software. This flexibility, not demonstrated by competing solutions, enables worldwide adoption of UWB systems.

Complexity/Power Consumption

The MB-OFDM system is specifically designed to be a low-complexity solution. A single analog receiver chain simplifies the overall architecture and, by limiting the transmitted symbols to a quadrature phase-shift keying (QPSK) constellation, the resolution of the DAC/ADC and the internal precision in the digital baseband can be reduced. Relatively large spacing between carriers also relaxes the phase noise requirements on the carrier synthesis circuitry and improves robustness to synchronization errors.

Battery life for mobile devices is a critical factor for consumer adoption. MB-OFDM is capable of supporting a minimum of two hours of continuous battery usage under typical conditions before a recharge is required.

Table 1: Estimated power consumption for a MB-OFDM system in a 90 nm CMOS process

Data Rate	Transmit power	Receive power	Deep sleep power
110 Mbps	93 mW	155 mW	15 µW
200 Mbps	93 mW	169 mW	15 µW

Security

The technology provides an embedded, always “on”, secure foundation. Security and privacy mechanisms are implemented at several levels of the protocol stack to ensure a robustness equal to the needs of a wireless technology while remaining transparent to the user. Experiences from Wi-Fi, Bluetooth and others have also guided the security architecture.

Digital Rights Management (DRM) is considered a separate issue that is addressed at the applications layer. However, system integrity for DRM implementation is ensured to allow it to ride transparently on the UWB platform.

Market Overview

UWB is a wireless radio technology for transmitting data point-to-point between consumer electronics, PC peripherals and mobile devices within short range at very high speeds, while consuming little power. Therefore, it is ideally suited for transfer of high-quality multimedia content, such as the wireless streaming of family videos from the digital video recorder to a high-definition television in the living room, or wirelessly connecting a mobile PC to a projector in a conference room to deliver a presentation.

Seamless connectivity is a compelling proposition to the typical consumer. Devices that automatically discover and communicate with each other, print or play on command without user intervention provides value in its simplicity. However, a confusing array of cables for various interfaces that will not and cannot talk to each other is the current reality.

Widespread adoption of UWB-based products will depend on ease of use at an affordable cost, hence the importance of low complexity CMOS solutions. Consumers also expect a reliable, consistent user experience. Interoperability is a key issue to allow transparent operation for the end user regardless of what brand they choose. Therefore, it is crucial to develop standards-based protocols and incorporate into a unified platform to deliver on these objectives.

Usage Models

The ability to display, edit, listen, share, and download content between devices in the home without becoming a networking technologist is an attractive proposition to many potential consumers. Three basic categories have evolved within the “typical” home environment: computing, multimedia,, and mobile communications devices. PC’s, printers and other peripherals, as well as residential gateways, modems, and routers represent primary elements of a data centric network; the broadcast entertainment cluster generally consists of home theaters with PVR’s, STB’s, video display monitors, audio equipment and camcorders; while mobile devices such as PDA’s, multifunction cell phones and laptops roam the premises.

The convergence of data, entertainment and mobile communications within the home has created the need for bridging these devices into a single network architecture more capable than legacy technologies of supporting and integrating each sector’s unique requirements.

- USB (Universal Serial Bus) was initially designed as a wired interface to tie associated peripherals to a host PC, typically utilized for applications in home offices and other family oriented user space and primarily geared towards the transport of data.

- IEEE 1394 (also known as FireWire®) was specifically designed to transmit multiple streams of audio and video over various types of cabling, used primarily for entertainment purposes. Many homes contain physically separate clusters for audio music, home theater equipment, and gaming console devices.

- Bluetooth is a low data rate connector replacement technology commonly found in mobile phones, headsets and PDAs.

While each of these somewhat disparate protocols has adequately addressed its respective target market segments, consumers want seamless interoperability both *within* and *between* the three segments which today often consist of several clusters of devices. To that end, industry standards groups such as DLNA are attempting to define methods to achieve whole home interoperability.

Typical applications are listed below:

Within the home:
- Download from video camcorder to PC for editing, then to TV for viewing
- PDA's synchronize data to PC
- Load games and audio/video files to PDA
- Connect laptop to game console
- Residential gateway to entertainment cluster
- Within the entertainment cluster –
    - Audio files from/to MP3 players from/to in-home storage devices i.e. Media PC hard drive and AV servers
    - HDTV to/from PVR and STB, store and (re)play streaming AV – requires between 19 – 24 Mbps
    - SDTV to/from PVR will consume between 3 – 7 Mbps
    - AV server or Media PC to DVD player, PVR's, HDTV, hand held appliances
    - DVD or AV server to headset

Automotive segment:
- Distribution of content for in-vehicle entertainment systems
- Cell phone to headset for hands free operation

While traveling:
- Digital still camera or camera phone photos transfers to printer or public kiosk
- Downloading games or movies to laptop in airport

Within the enterprise sector:
- Downloading a presentation from laptop to projector
- Desktop connectivity
- Synchronize PDA

Emerging trends

Increasingly, mobile devices that demand high-speed connectivity for rapid synchronization with fixed devices in both the office and the home are becoming consumer staples. This trend has been further accelerated by the convergence of functions, i.e. cell phones and PDAs that now include cameras and MP3 players as well as pocket PCs that are also capable of taking pictures, playing music and roaming wireless Internet networks; as well as the introduction of Personal Media Players (PMP's) or Personal Video Players (PVP's) and portable PVR's) that offer audio, video and imaging functionality.

Primary target applications

The penetration rate for each product category will be a function of:

- The ASP (Average Selling Price) of the target appliance
- The estimated cost evolution of implementation
- Barriers to entry and competitive threats
- Market conditions and general state of the economy
- Benefits to that specific market segment

High-end digital TV displays, typically incorporated into home theater clusters, represent a favorable market sector given the defined criteria. A July 2004 study from the Yankee Group reported that sales of high definition TV's (HDTV) increased 66 percent in 2003 and forecasted the installed base will grow to 12 million homes by year end. According to the study, there will also be nearly 48 million additional HDTV-enabled homes from 2005 through 2008. MPEG-2 creates bandwidth limitations even for SD (Standard Definition) video. Newer network infrastructures to better address emerging applications requirements will likely employ advanced video formats, including MPEG-4/H.264 or WMV-9. One of the primary factors driving this growth will be advancements in digital interfaces. From their report **"**Increased acquisition of digital video content via the PC and the cable/satellite set-top box, integration of digital content interfaces—such as HDMI, Firewire and potentially wireless connectivity—will enable a unified viewing environment for consumers bringing together multiple sources of video content."

The home theater segment will increasingly utilize intelligent platforms including Media PCs, advanced set top boxes (STBs), digital TV, or a networked control pad will manage and distribute digital content from devices such as personal video recorders (PVRs), DVD players, and multimedia phones to destination appliances, i.e. TV's, stereos, and wireless speakers. Digital Media Servers record and store media content, include advanced STBs, PVRs, PCs and laptop computers, stereo and home theater with hard disk drives, camcorders and digital still cameras, and multimedia mobile phones. Digital Media Players enable users to select and play media stored from either the home network or mobile devices. They include TV and other display monitors, stereo and home theaters, printers, PDAs, multimedia phones, game consoles and Digital Media Adapters. All of these devices are prime candidates to incorporate UWB functionality.

In addition to the home theater segment, where UWB will enable the most novice user to quickly and easily pull content from a PVR or camcorder to display on the TV screen, the office environment represents several target applications. For instance, files can be almost instantaneously downloaded from a PDA to synchronize to the desktop as well as sends photos from a camera phone directly to the printer.

International Scope

Silicon providers and OEMs worldwide are evaluating regional considerations to address the market needs of their customer base. They are developing MB-OFDM UWB solutions to provide the throughput, battery life, ease of use and compliance with regulatory requirements to ensure global adoption.

- APAC and Japan – these regions have a very high DSL penetration rate; broadband access encourages the deployment of home networking and multimedia applications. Also, the use of new multifunction mobile and personal devices are quickly adopted within this sector. Both factors indicate that the Asia Pacific region is likely to represent a significant market for WPAN devices.
- Middle East and Africa – growth in mobile handsets in these underdeveloped yet emerging markets could represent significant opportunities according to a July IDC report

- EU – Broadband penetration to 20% of all homes as well as progressive deployments of HDTV and upgrading to multifunction mobile phones will drive the markets for UWB products once regulatory approvals are obtained.
- The Americas – considered the early adopter market. Factors such as gaining early FCC approval for UWB, exponential growth in the home theater segment, the existing install base of USB and 1394, and widespread use of mobile personal devices are creating a broad market.

Proprietary UWB Technologies and Applications

UWB frequency spectrum is also being utilized for applications such as collision and obstacle avoidance radars, precision geo-positioning systems for personnel location, asset tracking and inventory control, and intelligent transportation systems. Several companies are developing technologies to specifically address the need for robust and secure wireless communications within various sectors.

Healthcare

Life critical functions such as locating diagnostic equipment and transfer of patient data in hospital environments can be accomplished with the development of hardware/software platforms that provide tracking of objects by maintaining constant radio contact with a network of sensors that have been placed throughout a designated area or building.

Emergency Operations

Similarly, these systems can enable pinpoint positioning for the purpose of rescuing persons in event of structural fires and other situations such as natural disasters, airport emergencies, toxic release accidents and terrorist events.

Military

The Naval Air Systems Command has issued contracts for UWB based Aircraft Wireless Intercommunication Systems (AWICS). DARPA (Defense Advanced Research Projects Agency) has sponsored a project to develop pager-sized units powered by AAA-sized cells that are capable of localization to *sub-meter* accuracy over 100-meter distances in networks of up to a few hundred Localizers.

Technological requirements for these niche applications are generally considered outside the scope of this document.

Industry Standards Groups and Relationships

The MBOA-defined radio provides one of the key building blocks to achieve the vision of an entire ecosystem of companies who will offer consumers a broad set of complementary home networking products and services

The entire radio platform however is comprised of two core elements. The UWB radio layer and the convergence platform together form the underlying transport mechanism for different applications that would operate on top, including wireless universal serial bus (USB), IEEE 1394, and the new Digital Living Network Alliance (DLNA) framework.

MultiBand OFDM Alliance
Established in 2003 and formalized into a Special Interest Group (SIG) in 2004, the MultiBand OFDM Alliance (www.multibandofdm.org) is dedicated to promoting the global standard for ubiquitous ultrawideband (UWB) wireless solutions. Its 170+ members include the world's leading semiconductor, personal computing, consumer electronics and mobile devices.

MBOA specifications for a physical layer ("PHY") are complete while specifications for its media access controller layer ("MAC") are being developed with completion expected by the end of 2004. Upon completion, the specifications will be made available to MBOA member companies.

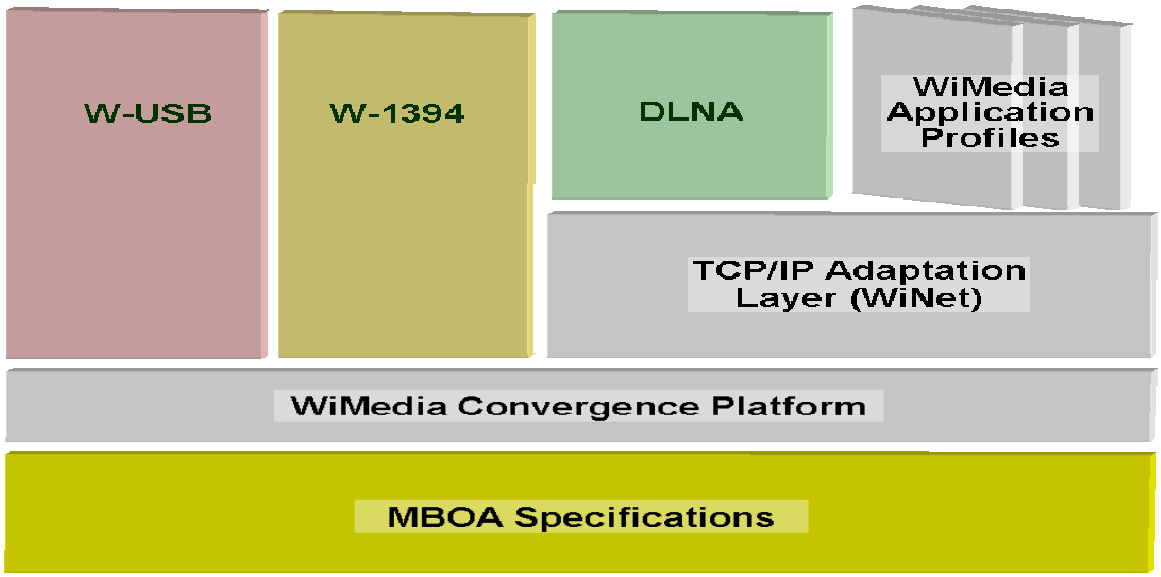


Figure 3: Relationship among components of the multi-application protocol stack

WiMedia Alliance

The WiMedia Alliance (www.wimedia.org) was formed to promote wireless connectivity and interoperability among multimedia devices within a personal operating space. This industry group is developing a common abstraction platform, as shown in Figure 3, which will enable multiple applications to run on one common radio. Based on broad industry support and the strong technical attributes of MB-OFDM, the Alliance in May 2004 endorsed MBOA's specifications for use with the WiMedia Convergence Platform. The combination of the MB-OFDM UWB radio with this convergence architecture establishes the foundation for the implementation of wireless versions of USB, IEEE 1394, DLNA and other IP-based application protocols.

WiMedia is creating several specifications that will enhance the performance of next generation solutions:

- The WiMedia Convergence Platform Architecture (WiMCA) will provide a common multi-vendor interoperable foundation for any application protocol. The platform establishes fairness policies for any entity accessing the UWB radio channel. Provisions for security and quality of service elements are built into the convergence platform.

- The WiMedia Network Encapsulation Protocol (WiNEP) will augment the convergence platform with TCP/IP services.

- The Streaming Media Profile (SMP) defines protocols and formats for streaming multimedia content using UPnP/IP primitives. While ensuring appropriate QoS provisions such as low latency and synchronization, the focus is on delivering ease-of-use to the consumer.

- Digital Imaging & Printing Profile (DIP) specifies the application protocol and formats on UPnP/IP to achieve high speed and high reliability imaging and printing applications, again focusing on delivering ease-of-use to the consumer.

Further, the WiMedia profiles overlap with and leverage the DLNA's recommended practices for in-home connectivity. Both are based on IP applications and Universal Plug and Play (UPnP) methods to discover devices.

Media Class	Required Format Set	Optional Format Set
Image	JPEG	PNG, GIF, TIFF
Audio	LPCM	AAC, AC-3, ATRAC3plus, MP3, WMA9
AV	MPEG2	MPEG1, MPEG4, WMV9

Table 2: Media formats to support interoperability were established by DLNA

Key elements of the multi-media system according to DLNA:

- Industry collaboration
- Standards-based interoperability framework
- Compelling products

The MBOA is dedicated to achieving each of these key elements. To that end, more than 170 member companies including nearly all prominent providers of silicon and end user products for consumer electronics, personal computing and mobile devices have established a global standard, scalable to comply with the most stringent regional regulations.

Wireless USB Promoter Group

The Wireless USB Promoter Group was formed at the Spring 2004 Intel Developer Forum and is comprised of seven industry leaders — Agere Systems, HP, Intel, Microsoft Corporation, NEC, Philips Semiconductors and Samsung Electronics. In addition, Alereon, Appairent Technologies, Staccato Communications, ST Microelectronics, Texas Instruments, and Wisair are Key Contributors. The group was chartered with defining the wireless USB (WUSB) specification with a bandwidth of 480 Mbps and to maintain the same usage and architecture as wired USB with a high-speed host-to-device connection. With these considerations in place, WUSB will enable an easy migration path for today's wired solutions and provide ease-of-use and security similar to that of traditional USB.

1394 Trade Association

The 1394 Trade Association understands the evolutionary industry progression to provide wireless connectivity, especially for high speed applications. As such, they established a Wireless Working Group to specify a wireless protocol adaptation layer (PAL). The Trade Association in May 2004, published a wireless PAL for 55Mbps, whereby the significant and most fundamental elements for enabling a wireless protocol bridge were defined. With the consent of the Board of Directors, both the 1394-TA Wireless Working Group and the 1394-TA Compliance and Interoperability Working Group are now engaged with the MultiBand OFDM Alliance and the WiMedia Alliance, to define a platform as well as a compliance & interoperability plan for Wireless 1394a, operating at 400Mbps.

Industry Alignment

The MBOA radio specification, as an integral component of the WiMedia Convergence Platform, will provide the transport mechanism for Wireless USB, Wireless 1394, and emerging native IP based applications protocols. DLNA will include this standard in their design guidelines. Table 3 illustrates the industry alignment, listing leading companies that are members of two or more of the five SIG's discussed in this document.

Industry Participants	MOBA Members	WiMedia Members	DLNA Members	Wireless USB Members	1394TA Members
Agere Systems	√	√	√	√	√
Alereon	√	√		√	√
Appairent Technologies	√	√	√	√	√
Broadcom	√		√		√
Conexant		√	√		
Epson (Seiko)	√	√	√		√
Fujitsu	√		√		√
Hewlett Packard	√	√	√	√	√
Hitachi	√		√		√
Infineon	√	√	√		√
Intel	√	√	√	√	√
Kodak		√			
LG Electronics	√	√	√		√
Microsoft	√		√	√	√
Mitsubishi	√		√		√
Motorola (Freescale)		√	√		√
NEC	√		√	√	√
Nokia	√		√		
Pansonic	√		√		
Phillips Semiconductor	√	√	√	√	√
Renasas	√				√
Samsung Electronics	√	√	√	√	√
Sharp Labs	√	√	√		√
Staccato Communications	√	√		√	√
Sony	√		√		√
ST Microelectronics	√	√	√	√	
Taiyo Yuden (TRDA)	√	√			√
TDK	√	√			
Texas Instruments	√	√	√	√	√
Toshiba	√	√	√		√
TransDimension	√	√			
Wisair	√	√		√	
WiQuest	√				

Table 3: Industry alignment is demonstrated by participation in the key industry forums

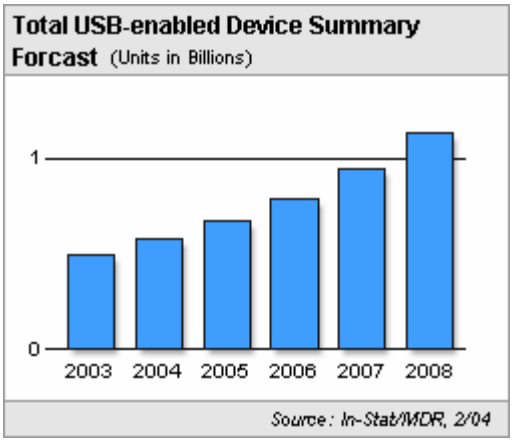
Technologies Adopting the UWB Radio Platform

Native IP based applications

Based on the WiMedia Convergence Platform, new profiles have been defined to interoperate with other home networking protocols.

Universal Serial Bus

USB currently has an installed base of more than one billion ports with an additional 2.5 billion interfaces forecasted to ship by 2006. While primarily PC based now, USB is branching out to address broader markets. The fast growing camera phone segment is quickly adopting USB to facilitate downloading photographs. USB On-the-Go (OTG) defines a dual role where the port can act as either a device or a host and thus operate in a quasi peer-to-peer mode.

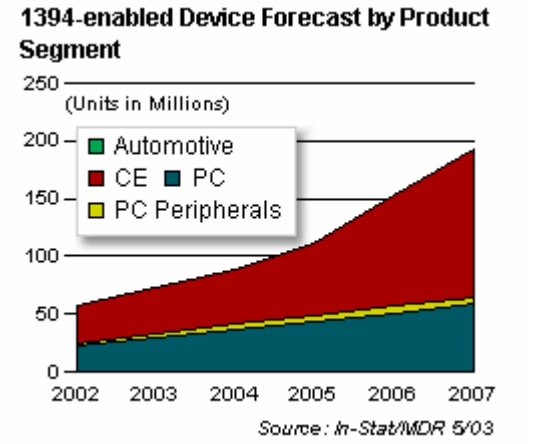


The Wireless USB Promoters Group, formed in February 2004, is chartered with defining the WUSB specification with a targeted data rate of 480 Mbps using the MB UWB radio. It will be backward compatible with legacy wired USB interfaces, and capable of high rate streaming isochronous transfers. Dongle adapters will be used to communicate with traditional USB ports. The protocol will ensure the same level of encryption as wired USB.

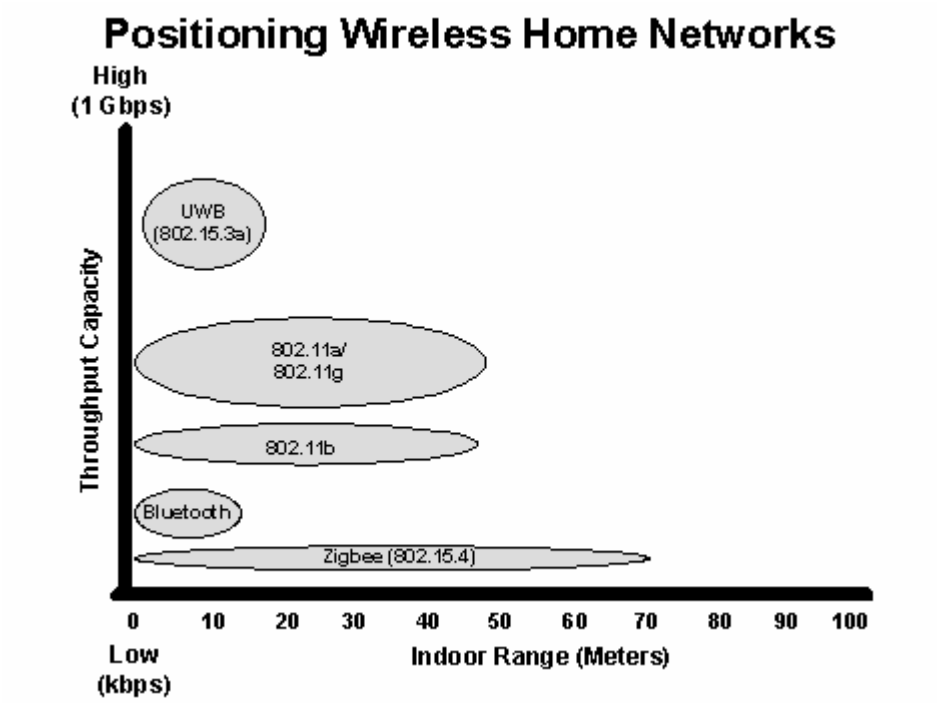
IEEE 1394 (or FireWire®)

By the end of 2003, more than 50 million devices were FireWire-enabled. In part driven by the FCC mandate that by 2007 all cable boxes and HDTV tuners will have 1394 interfaces, the install base is expected to approach 200 million units within that timeframe.

Wireless 1394 will support up to 400Mbps and be backward compatible to legacy wired devices. The 1394 Trade Association approved a protocol adaptation layer to bridge between applications developed for wired 1394 and the WPAN 802.15.3 MAC. The Association also has established a liaison with WiMedia to cooperate in future standards development.



Why UWB vs. other technologies?



WiFi

The primary limitation for intended usage models are power requirements, energy consumption, and lower data rates. Also, WiFi is an infrastructure-oriented technology and therefore has difficulty communicating peer-to-peer, that capability was added to WiFi after the fact.

Current implementations of WiFi were not designed for streaming audio and video, although they generally work well for the transfer of data. While efforts have been completed by the "e" Task Group to address quality of service (QoS) deficiencies in the 802.11 standard, Wi-Fi is being *adapted* to support multimedia applications through additions to an already relatively complex MAC. This complexity makes the technology inherently more expensive, and the requirement for backward compatibility places an ultimate limitation on WiFi efficiency and throughput. Also, both 802.11b and 802.11g operate in the noisy 2.4GHz ISM band and are subject to interference and oversubscription issues that can result in latency and jitter. Not only are transfer rates slower, topping out at 54Mbps if full data rates could ever be achieved, but power consumption also remains an issue requiring at least an order of magnitude higher than UWB for a comparable file transfer.

Similar to its predecessors, the next generation WiFi (IEEE 802.11n) is expected to become an effective high speed networking technology. Based on an Ethernet heritage and backwards compatibility requirements, it cannot be completely optimized for point-to-point connectivity such as streaming A/V. Based on data rates and power consumption specified in the developing 802.11n standard, it is doubtful that the technology will effectively compete with UWB in many usage models. Therefore, it is expected that both 802.11n and UWB will support separate target market segments, coexisting and complementing each other, but essentially not competing within their respective spaces- not unlike Gigabit Ethernet and USB 2.0.

Bluetooth

Although designed as a low power replacement for cable technologies, Bluetooth consumes 50x as much power to transfer a single bit as UWB. The recently released Bluetooth Version 1.2 supports data rates only up to 2 Mbps but has implemented methods for enhanced voice quality and audio. Version 2.0 is under development, promising to extend rates up to 12 Mbps. However, that is still only a fraction of UWB rates. In addition, interference problems with WiFi have been common, since both technologies occupy the same 2.4GHz ISM band, and Bluetooth specifications do not require monitoring for traffic prior to transmitting.

WiMAX

Personal Media Players (PMPs) or Personal Video Players (PVPs) equipped with this technology will be capable of downloading content from DVDs, PVRs, etc and some offer the ability to act as a content platform or portable PVR to project to big screen displays. This capability may compete directly with one or more of UWB's primary target applications. WiMAX-enabled devices would be connected directly to the Internet and share data with other in–premises devices through that link. Cable MSOs (Multi System Operators) are considering WiMAX to distribute video within the home, given the technological limitation of WiFi.

Business Case Justification

UWB products currently under development are being designed from the ground up to provide the functionality to meet market requirements for high speed point-to-point connectivity in the home entertainment and office environments. Given the expectation of broad market acceptance, and the current install base of USB (1.5 billion ports) and 1394 (50 million ports) that could be connected via UWB dongles, some of the forecast provided in this section may be considered conservative.

- A market estimate in the draft ETSI TR 101 994-1 considers that more than half a billion UWB-enabled devices will be in operation by the year 2010 and at least 150 million of them in Europe.

- According to Parks Associates, the size of the total addressable market for home connectivity is expected to grow to over 460 million nodes by 2008. "The true promise and potential reality for ultrawideband is its cross-category acceptance as a cable replacement solution," reports Kurt Scherf, vice president and principal analyst for Parks Associates. "Its true measure of success, projected to number more than 180 million nodes shipped in five years, will be the continued support and deployment by major players in the computing, consumer electronics, and mobile communications markets."

- West Technology Solutions forecasts that annual shipments for Ultrawideband chipsets into the communications segment alone will exceed 63 million units by 2007

- Allied Business Intelligence (ABI) predicts that shipments of UWB chipsets could reach 45 million units by 2007

Standards Activities – Technology Rollout

The MAC (Media Access Control) and PHY (Physical Layer) specifications will be released to MBOA member companies by the end of 2004. Products will be available in early 2005, many of which will be displayed in working demonstrations at the CES (Consumer Electronics Show) in January 2005.

Requirements for next generation standards are in the process of being defined.

Regulatory Challenges/Successes

In July 2002, the International Telecommunication Union Radio Sector (ITU-R) assigned Task Group TG 1/8 the charter to study the appropriate spectrum management frame work related to the introduction of UWB devices and the compatibility between these devices and radio communications services. The TG was also divided into four Working Groups:

- WG1 - UWB technical and operation characteristics
- WG2 - compatibility with other radio services
- WG3 - spectrum management framework
- WG4 - measurement techniques for UWB emissions

ITU Recommendations are still pending. European countries in particular are looking more favorably upon UWB with its better control of spectrum and out-of-band emissions based on MB-OFDM, especially as it pertains to cellular phone systems. However, there does remain some controversy regarding UWB at 24GHz for collision-avoidance radar.

The US is currently the only major market where UWB is officially approved for use. Korea and Japan are expected to follow in early 2005 with preliminary regulations. In Europe, Germany has taken the lead on UWB and seems most likely to be the first to adopt regulation policy. Given the current momentum, it is likely that regulatory efforts will have been completed in a majority of the world markets by the end of 2005.

Conclusions

The convergence of data, entertainment, and mobile communications within the home has created the need for economical technologies and architectures capable of integrating both legacy and new Personal Area Networks. UWB technology is uniquely qualified to address that requirement and was designed specifically to support high speed, short range, point-to-point wireless communications. Further, the industry has endorsed MB-OFDM and is establishing design guidelines and standards based on this radio platform to ensure interoperability and coexistence between protocols for various interfaces including Wireless 1394, Wireless USB, and native IP-based applications.

MBOA-SIG specifications are scheduled for release in Q4 of 2004. Compliant products will be available in early 2005. The remaining hurdles will be completion of the regulatory work already in progress.

As WiFi has freed consumers from Ethernet cables, MB-OFDM UWB looks to liberate consumers from the other wires that comprise the rats' nests behind their PC's, home entertainment systems, and offices. The ecosystem will then have achieved its vision.