



## Wireless USB

### The First High-speed Personal Wireless Interconnect

**On February 17, 2004, at the Intel® Developer Forum,** Intel Corporation and other technology industry leaders announced the formation of the Wireless USB Promoter Group. Focused on delivering the first high-speed personal wireless interconnect, the group includes Agere Systems, HP, Intel, Microsoft Corporation, NEC, Philips Semiconductors, and Samsung Electronics.

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**Overview**

The Universal Serial Bus (USB), with one billion units in the installed base, is the most successful interface in PC history. Projections are for 3.5 billion interfaces shipped by 2006. Benefiting from exceptionally strong industry support from all market segments, USB continues to evolve as new technologies and products come to market. It is already the de facto interconnect for PCs, and has proliferated into consumer electronics (CE) and mobile devices as well. USB enjoys strong brand recognition, has a well-recognized logo, and is supported by an experienced governing body—the USB Implementers Forum (USB-IF).

Wireless USB will build on the success of wired USB, bringing USB technology into the wireless future. Usage will be targeted at PCs and PC peripherals, consumer electronics and mobile devices. To maintain the same usage and architecture as wired USB, the Wireless USB specification is being defined as a high-speed host-to-device connection. This will enable an easy migration path for today’s wired USB solutions.

**Usage Models**

The growing use of wireless technology in PC, CE, and mobile communications products, along with the convergence of product functionalities, calls for a common wireless interconnect standard. The standard needs to work well with products and usage models from all three industries. To better understand what’s driving the need for a common standard, we’ll examine how these products will soon be used in home and business environments. We’ll also consider the rise of “dual-role” devices that include both host and device capabilities.

**Home Usage Scenarios**

The trend towards smaller form factors, portability and mobility in consumer electronics devices has led to the emergence of new classes of products. These products have rich functionality, multimedia capabilities, and require connection to other AV devices for display, editing, listening, sharing, and downloading of content. Within the home, for instance, a family may have a digital video camcorder, digital still camera, portable MP3 player, PDA, tablet PC, wireless speakers, and personal video display device.

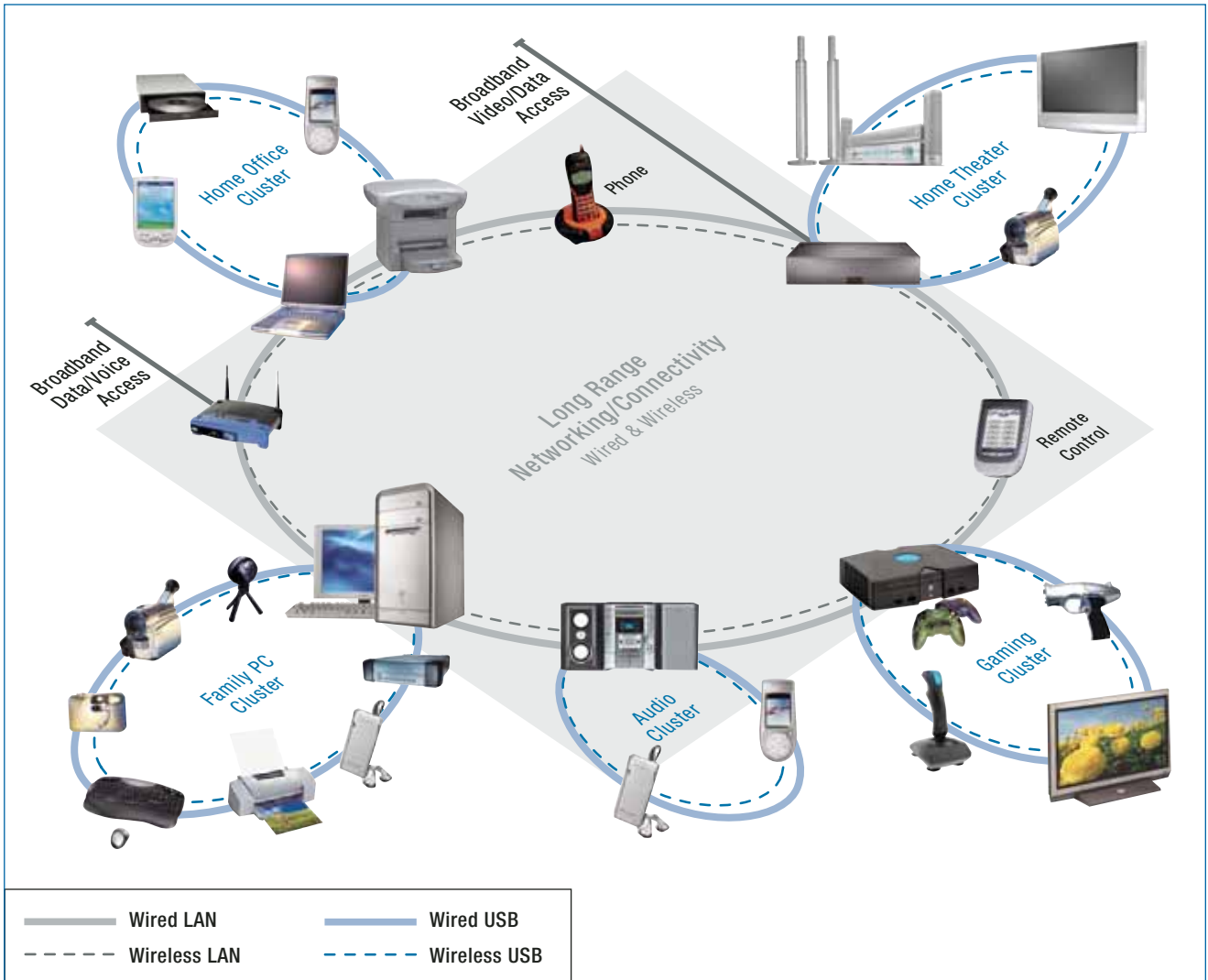


Figure 1. Home usage scenarios that could be “unwired” with Wireless USB.

Each of these portable devices has a need to connect to other devices such as PCs or stationary consumer electronics products, such as stereos, HDTVs, video recorders, entertainment PCs, or the like. All these devices would benefit from the ability to connect without cables. Think, for instance, about the number of devices in your home and the tangle of wires between them. Wireless USB would eliminate these wires and enable devices to wirelessly connect to each other.

Naturally, the CE environment will have high expectations for performance. Many consumer usage models will center on demanding streaming media distribution using compression algorithms. Typical video delivery with standard SDTV/DVD can consume between 3 to 7 Mbps, while HDTV can require between 19 to 24 Mbps. A point distribution technology

**Some Top Candidates for Wireless USB Devices in the Home:**

- Entertainment PC
- Digital Camcorder
- Digital Still Camera
- HDTV
- DVD-RW/CD-RW (Recorder/Player)
- External Storage Device (HDD)
- Game Console
- MP3 Player
- Set Top Box
- PDA or other handheld mobile device
- Personal Video Player (PVP)
- Personal Video Recorder (PVR)
- Printer



Figure 2. Office usage scenarios for Wireless USB.

like Wireless USB with its projected effective bandwidth of 480 Mbps, could manage multiple HDTV streams while still having the capacity to support other high-bandwidth data streams. Host buffering could enable a network backbone to effectively distribute content to all distribution hosts, enhancing the quality experience for all users. The Wireless USB specification will be an effective way to ensure that the delivered convenience and quality of service meets typical consumer entertainment expectations.

### Office/Business Usage Scenarios

Connectivity issues and other inconveniences of wired connections can hurt productivity and slow the adoption of new devices within the work environment. Users of mobile computers and PDAs particularly face connection challenges as they move from place to place and want to use printers and other devices. Wireless USB could simplify their lives while providing a time-saving, high-speed connection that enhances productivity (see Figure 2). In this section, we give some typical scenarios of how Wireless USB could enhance connectivity in the office.

#### Dedicated Office Services

Executives, managers and heavy users need faster, dedicated services in their office rather than those shared on the network. With Wireless USB, devices such as inkjet and laser printers, scanners, external storage devices, and PC cameras can quickly connect and exchange data at high speed. Top Wireless USB uses will probably include: simultaneous and frequent-use mass storage for data backup, printer connectivity, scanner connectivity, and PDA or cell phone synchronization.

#### Printing to Enterprise Printer

For office workers that are very mobile and frequent different areas of an enterprise, the option of easily printing from a mobile platform (notebook PC, PDA, cell phone, etc.)

#### Some Top Candidates for Wireless USB Devices in the Office:

- Digital Projector
- Headset and Speakers
- Mass Storage (HDD, DVD-RW, CD-RW, etc.)
- Mobile Phone
- PC Camera
- PDA
- Printer
- Scanner

is very attractive. With Wireless USB, a worker could simply approach the nearest printer or multi-function device and print the needed documents. This would alleviate many of the inconveniences today in finding a printer on a network and connecting to it.

### **Synchronizing a PDA with a Network**

In industries such as medical, manufacturing and retail where mobile devices are becoming pervasive, having wireless data-synchronization ability would allow users to quickly sync with a central computer to update the information in corporate database. Wireless USB, for example, could enable medical professionals making rounds to take notes and collect data on patients via handheld or PC tablet, and then quickly sync with the network to access additional patient data/history and treatment plans.

### **Sharing of Peripheral Devices**

Wireless USB will enable colleagues to more easily share devices and use each other's devices within an office envi-

ronment. Easy sharing of scanners, printers, storage devices, and other possible peripherals would be possible. Exchanging large files off hard disk drives without sending them through e-mail or over the network would be possible.

### **Dual-role Devices**

A new class of Wireless USB dual-role devices is projected to eliminate wires in many usage scenarios and enable new uses not previously possible. These devices will offer both limited host and device capabilities, similar to that experienced with USB On-The-Go. (USB OTG is the wired USB specification defining dual-role devices which can act as either hosts or peripherals, and can connect to PCs or other portable devices through the same connector.) Figure 3 shows some dual-role device usage scenarios. More detailed descriptions of various scenarios are also provided.

### **Camera to Printer**

Wireless USB could enable people to wirelessly download and print digital photos to a color printer. Imagine taking



**Figure 3.** Dual-role devices usage scenarios.

pictures at an amusement park and being able to share copies immediately by transmitting the pictures to a printer at a digital photo kiosk.

**Digital Camcorder to Digital Display**

Instead of having to run a cable from your digital camcorder to the video and audio ports of a display device, Wireless USB would enable you to connect without wires. You could instantly share your video with friends and family.

**MP3 Player to Wireless Speakers**

Many people already carry their music wherever they go. Imagine being able to connect to high quality surround sound speakers wherever you are. With Wireless USB, you could forget cables. Just hit play and listen.

**Digital Content Transfer to Personal Video Player**

Wireless USB would enable hours of content to be transferred in minutes from a personal video recorder or set top box to a personal video player. You could catch up on the morning news, a movie or sitcoms wherever the day takes you.

**Technology Requirements**

**Topology**

The fundamental relationship in Wireless USB is the “hub-and-spoke” topology, as shown in Figure 4. The host initiates all the data traffic among the devices connected to it, allotting time slots and data bandwidth to each device connected. These relationships are referred to as clusters. The connections are point-to-point and directed between the Wireless USB host and Wireless USB device. The main difference here from wired USB case is that there are no hubs present in the connection topology. The Wireless USB host can logically connect to a maximum of 127 Wireless USB devices.

Wireless USB clusters co-exist within an overlapping spatial environment with minimum interference, thus allowing for a number of other Wireless USB clusters to be present within the same radio cell. In addition to providing wireless connectivity, Wireless USB will be backward compatible with wired USB and provide bridging to wired USB devices and hosts. A method will be required to enable the exchange of data between clusters or devices not related to the same

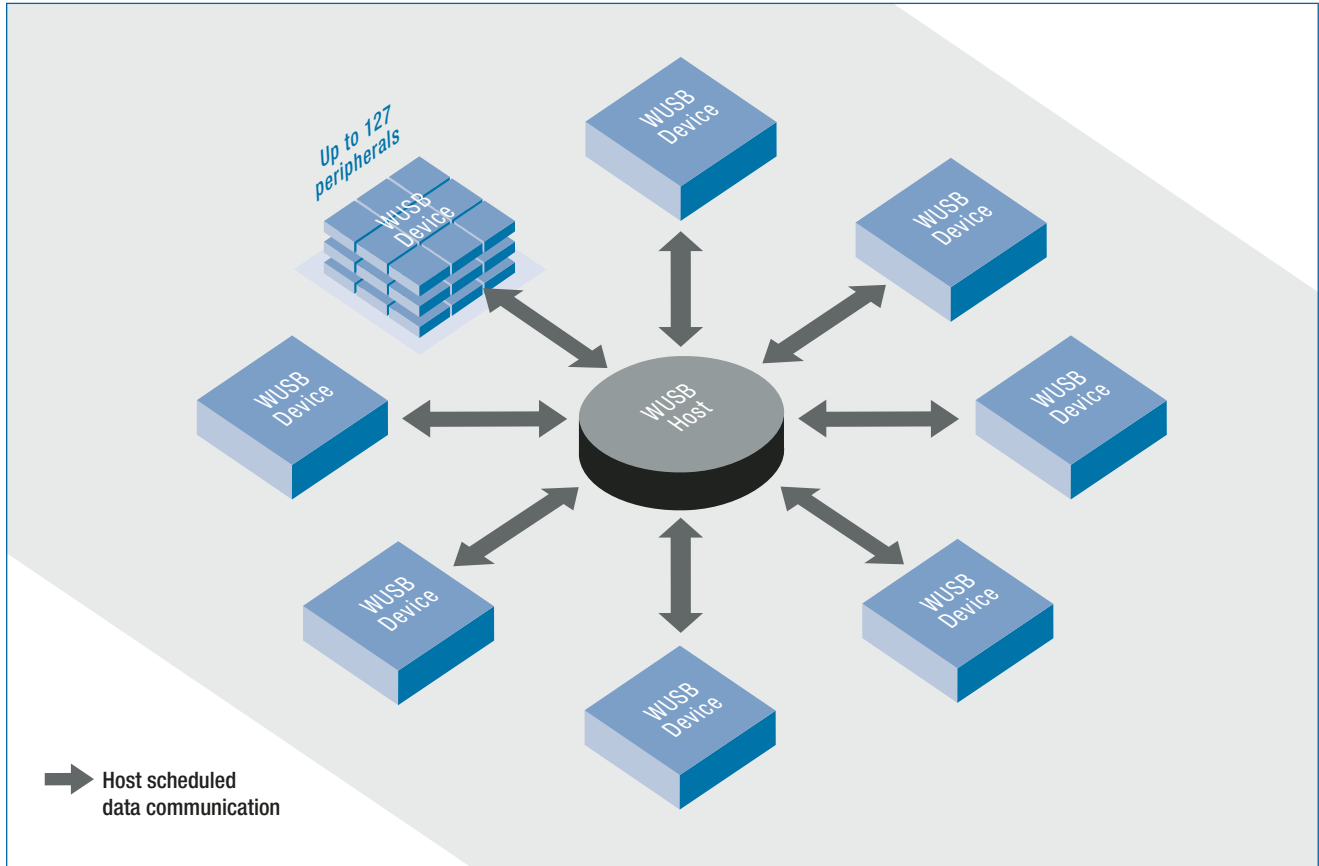


Figure 4. Wireless USB Topology.

host. This method may be a second-level connection between two hosts (i.e., a network) or some method of transferring data between two clusters not managed by the same host.

Wireless USB technology will support the following attributes:

- Simple, low-cost implementation. The implementation will follow the wired USB connectivity models as closely as possible to reduce development time and to preserve the low-cost, ease-of-use model which has become pervasive in the PC industry.
- A point-to-point connection topology supporting up to 127 devices that follows a similar host-to-device architecture as used for wired USB.
- High spatial capacity in small areas to enable multiple devices access to high bandwidth concurrently. Multiple channel activities will be able to occur within a given area. The topology will also support multiple clusters in the same area. The number of clusters to be supported is yet to be determined.
- A dual-role model where a device can also provide limited host capabilities. This model would allow mobile devices to access services with a central host supporting the services (i.e., printers and viewers). It would also allow devices to access data outside a cluster they are connected to by creating a second cluster as a limited host.

## Performance

Wireless USB performance at launch will provide adequate bandwidth to meet the requirements of a typical user experience with wired connections. The 480 Mbps initial target bandwidth is comparable to the current wired Hi-Speed USB standard. With 480 Mbps as the initial target, the Wireless USB specification will allow for generation steps of data throughput. As the Ultra-Wideband (UWB) radio Wireless USB is based on evolves and future process technologies take shape, bandwidth could exceed 1 Gbps. The specification intends for Wireless USB to operate as a wire replacement with targeted usage models for cluster connectivity to the host and device-to-device connectivity at less than 10 meters.

## Radio System Power and Power Management

Radio system power (power used only by the radio) will be expected to meet the most stringent requirements, particularly where mobile and handheld battery life is important. A typical PDA uses between 250-400 mW without a radio connection. Cellular phones typically use 200-300 mW with the primary WAN radio. Adding a Wireless USB radio should not increase power requirements such that battery life would be reduced more than by existing wireless technologies employed today. Battery-powered operation requires reasonable battery life – 3 to 5 days for highly mobile devices and several months for intermittently used devices like remote controls. Wireless USB based on MultiBand OFDM Alliance (MBOA) radio will strive to meet this standard. The power target for Wireless USB radio will be less than 300 mW at introduction and drive to a target of 100 mW over time.

Creative power management techniques will be used to preserve battery life. The radio, for instance, will sleep when possible and wake upon request. Power will also be conserved by stopping power-draining operations during idle periods.

### The Radio

**Wireless USB will be based on the Ultra-Wideband (UWB) radio efforts by the MultiBand OFDM Alliance (MBOA) and the WiMedia\* Alliance. Both are open industry associations that promote personal-area range wireless connectivity and interoperability among multimedia devices in a networked environment.**

**With the formation of the MBOA ([www.multibandofdm.org](http://www.multibandofdm.org)) in June 2003, OFDM for each sub-band was added to the initial multiband approach to develop the best technical solution for UWB. To date, the MBOA has more than 60 participants that support a single technical proposal for UWB.**

**In the multiband OFDM approach, the available spectrum of 7.5 GHz is divided into several 528 MHz bands. This allows the selective implementation of bands at certain frequency ranges while leaving other parts of the spectrum unused. The dynamic ability of the radio to operate in certain areas of the spectrum is important because it enables adaptation to regulatory constraints imposed by governments around the world.**

## Security and Device Association

Wireless USB security will be designed to deliver the same level of security as wired USB. Connection-level security between devices, for instance, will be designed to ensure a device is associated and authenticated before operation of the device is permitted. Higher levels of security involving encryption will be implemented at the application level. An important goal will be to ensure that processing overhead supporting security does not impose noticeable performance impacts or device cost.

In regards to device association, one of the primary objectives when implementing Wireless USB will be to make sure it enables easy installation and operation. In a way, wireless technology presents new challenges to ease of use. That's because wired connections provide the user with very direct expectations. In essence, when they plug a device in, (i.e., when the wire is connected), the user can see the connection is made (or not made if the plug doesn't fit). Wireless connections on the other hand, due to environmental characteristics, may establish connection paths that are not obvious. In fact, it may not be obvious when a device is connected.

To facilitate device associations, the Wireless USB specification will include the following requirements:

- An easy way for consumers to connect Wireless USB devices and hosts (the focus of device connection or "pairing" will be simplicity and ease-of-use)

- Mutual authentication in device and host connections so that devices will have the opportunity to validate the host and the host will have the opportunity to validate the device
- World class security as a standard and non-removable feature for all certified Wireless USB devices
- Asymmetric host-centric model that maintains the USB model of cheap/simple devices and confines the complexity to the host

## Future

Intel and fellow travelers will continue to drive the Wireless USB initiative into the marketplace as the first commercial application to run on top of the common UWB radio platform. A completed Wireless USB specification is expected by year's end. The first Wireless USB implementations will be in the form of discrete silicon that will be introduced in a number of form factors. These include add-in cards and dongles, along with embedded solutions to support the technology's introduction and subsequent rapid ramp-up. The wireless future will truly arrive once Wireless USB, along with the Common Ultra-Wideband Platform, becomes a standard part of every processor and chipset, integrated in CMOS silicon. The goal is for Wireless USB to become the wireless interconnect of choice for desktop and mobile PCs, handheld, mobile, and consumer electronic devices, allowing easy connection and data exchange at high speeds without wires.

**For More Information** You can learn more about Wireless USB and UWB at the following:

### Industry Organizations

*Universal Serial Bus*

*Implementors Forum* – [www.usb.org](http://www.usb.org)

*MultiBand OFDM Alliance* –  
[www.multibandofdm.org](http://www.multibandofdm.org)

### Intel Web Pages and Papers

*Universal Serial Bus* – [www.intel.com/technology/usb](http://www.intel.com/technology/usb)

*Ultra-Wideband* – [www.intel.com/technology/ultrawideband](http://www.intel.com/technology/ultrawideband)

*Ultra-Wideband Overview Paper* – [www.intel.com/technology/ultrawideband](http://www.intel.com/technology/ultrawideband)

*Intel Research and Development* – [www.intel.com/technology](http://www.intel.com/technology)

*Intel Communications Technology Lab* – [www.intel.com/technology/perfnet](http://www.intel.com/technology/perfnet)

*Radio Free Intel* – [www.intel.com/technology/radio](http://www.intel.com/technology/radio)

(Intel's vision of anytime, anywhere connectivity through radio in silicon.)

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