An introduction to Wireless USB (WUSB)

Overview: Unwiring USB

Imagine if all the devices in a home office -- such as printer, scanner, external hard drive, and digital camera -- could be connected to your PC without any wires. Imagine if all the components for an entire home entertainment center could be set up and connected without a single wire. Imagine if digital pictures could be transferred to a photo print kiosk for instant printing without the need for a cable. These are just some of the possible scenarios for high-speed wireless USB (WUSB) connectivity, the latest technology developed to bring even greater convenience and mobility to devices.

Universal serial bus (USB) technology has been a popular connection type for PCs and it's migrating into consumer electronic (CE) and mobile devices. Now this high-speed and effective connection interface is unwiring to provide the functionality of wired USB without the burden of cables. This next iteration of USB technology is the focus of the new Wireless USB Promoter Group, which will define the specifications that will eventually provide standards for the technology.

Wireless USB Promoter Group

At the Spring 2004 Intel Developer Forum, formation of the Wireless USB Promoter Group was announced. The group is comprised of seven industry leaders: Agere Systems, HP, Intel, Microsoft Corporation, NEC, Philips Semiconductors and Samsung Electronics.

The Wireless USB Promoter Group is chartered with defining the wireless USB (WUSB) specification. Already there has been some progress with the definition of a WUSB specification with a targeted bandwidth of 480 Mbps. This specification maintains the same usage and architecture as wired USB with a high-speed host-to-device connection. With these considerations in place, it will enable an easy migration path for today's wired USB solutions.

Additionally, WUSB specifications will be based on ultra wideband (UWB) radio efforts by the MultiBand OFDM Alliance (MBOA) and WiMedia Alliance, both open industry associations that promote personal-area range wireless connectivity and interoperability among multimedia devices in a networked environment.

WUSB Topology

The fundamental relationship in WUSB is a hub and spoke topology, as shown in **Figure 1**. In this topology, 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 WUSB host and WUSB device.

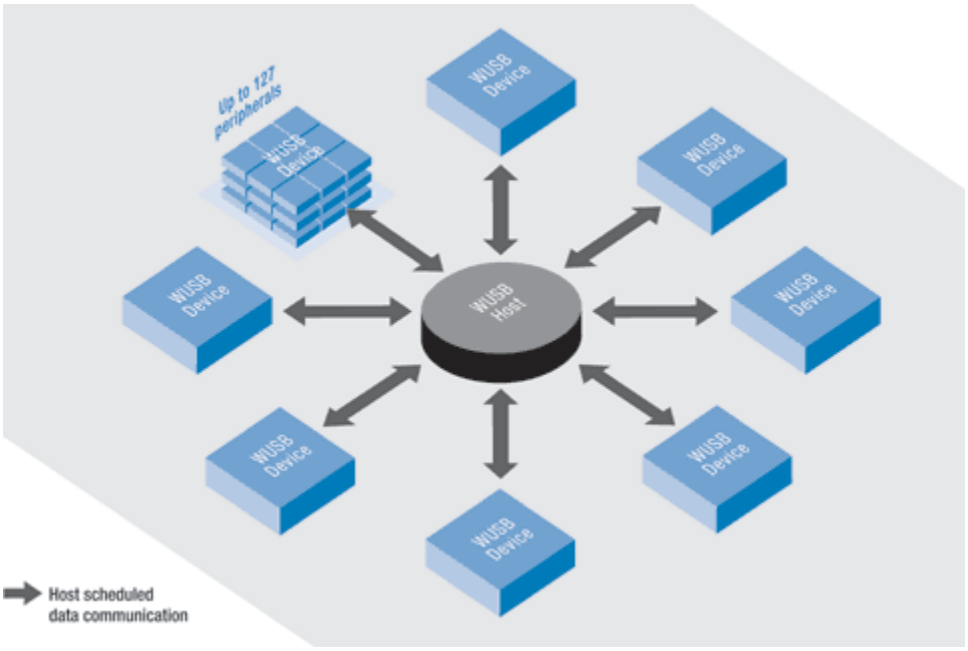

Figure 1 -- WUSB topology

The WUSB host can logically connect to a maximum of 127 WUSB devices, considered an informal WUSB cluster. WUSB clusters coexist within an overlapping spatial environment with minimum interference, thus allowing a number of other WUSB clusters to be present within the same radio cell.

Topology will support a dual role model where a device can also support limited host capabilities. This model allows mobile devices to access services with a central host supporting the services (i.e., printers and viewers). This model also allows a device to access data outside an existing cluster it may currently be connected to by creating a second cluster as a limited host.

Additionally, high spatial capacity in small areas is needed to enable multiple device access to high bandwidth concurrently. Multiple channel activities may take place within a given area. The topology will support multiple clusters in the same area. The number of clusters to be supported is still being determined.

Design Considerations

There are several architectural considerations in developing WUSB. In addition to providing wireless connectivity, WUSB must be backwards compatible with wired USB and provide a bridge to wired USB devices. Also, the host and solutions will need to enable the exchange of data between clusters or devices not related to the same host.

Low-cost implementation of WUSB will also be important to the successful integration of the technology. Implementation will follow the wired USB connectivity models as closely as possible to reduce development time and to preserve the low-cost, easy-to-use model, which has become pervasive in the PC industry.

Performance

WUSB 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 of WUSB is comparable to the current wired USB 2.0 standard. With 480 Mbps being the initial target, WUSB specifications will allow for generation steps of data throughput as the ultra wideband radio evolves and with future process technologies, exceeding limits of 1 Gbps.

The specification is intended for WUSB 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. The interface will support quality delivery of rich digital multimedia formats, including audio and video, and will be capable of high rate streaming (isochronous transfers).

Radio System Power and Power Management

Radio system power (power used only by the radio) will be expected to meet the most stringent requirements where mobile and handheld battery life is important. For example, typical PDAs use 250–400 mW without a radio connection, while typical cellular phones use 200 mW–300 mW with the primary WAN radio. Adding a WUSB radio should not increase power requirements any more than existing wireless technologies already employed today.

Battery-powered operation requires reasonable battery life: 2–5 days for highly mobile devices and several months for intermittently used devices like remote controls. WUSB, based on the MultiBand OFDM Alliance (MBOA) radio, will strive to meet these standards. The power target for WUSB radio will be introduced at less than 300 mW and drive to a target of 100 mW over time.

Dual-Role Devices

A new class of devices, called WUSB dual-role devices, will give rise to usage scenarios not previously possible. These devices will offer both limited host and device capabilities similar to USB On-The-Go.

Usage Applications

With the growing use of digital media in the PC, consumer electronic (CE) and mobile communication environments, a common standard interconnect is needed to support the on-going convergence of these environments. The trend toward convenient wireless distribution of digital information provides an opportunity to introduce a single, standard wireless interconnect capable of supporting usage models across all three environments.

The CE environment will have high-performance wireless interface expectations. Consumer usage models (**Figure 2**) will center on streaming media distribution that typically uses compression algorithms. The performance objective is to ensure a high quality of service is maintained to meet typical consumer entertainment expectations.

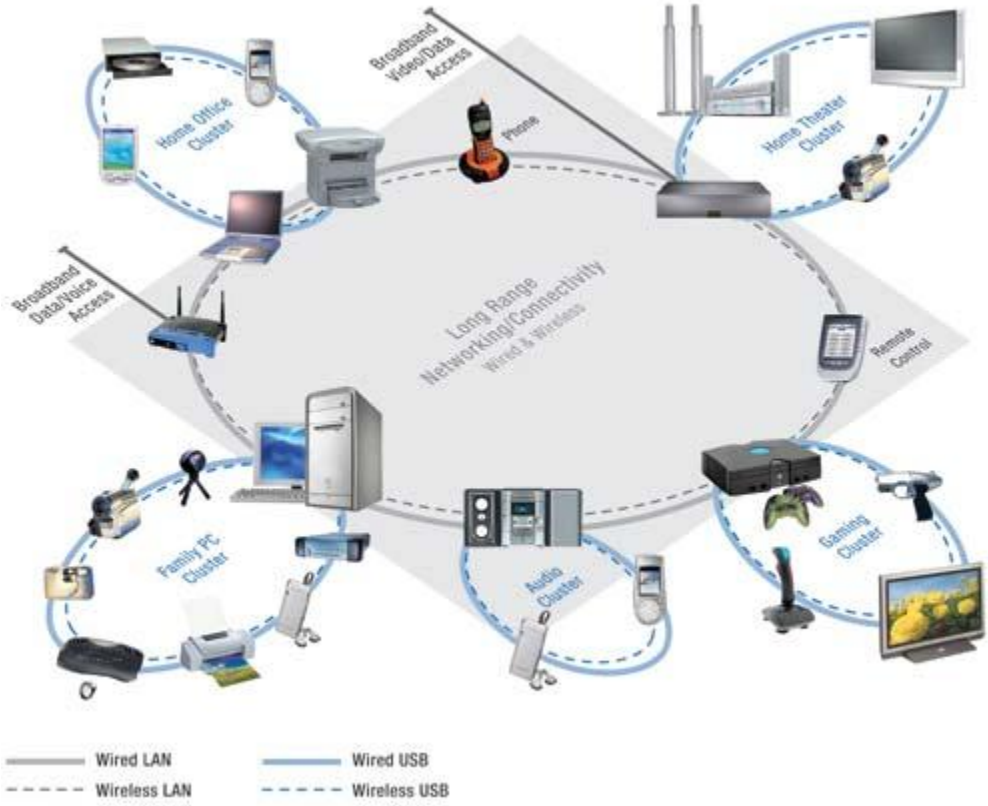

Figure 2 -- Consumer Usage Models

Typical video delivery with standard SDTV/DVD will consume between 3 and 7 Mbps while HDTV will use between 19 and 24 Mbps. A point distribution technology like wireless USB with an effective bandwidth of 480 Mbps could manage multiple HDTV streams. Host buffering could enable a network backbone to effectively distribute content to all distribution hosts, enhancing the quality experience for all users.

Business applications for WUSB include a variety of different usage possibilities. Common devices such as printers, scanners, hard drives, and projectors could all be used in wireless scenarios. These devices would function the same way as if they were using wired USB, but without all the cables. Office services on the corporate network could migrate to WUSB and benefit from faster performance than shared network devices offer.

Security and Device Association

WUSB security will ensure the same level of security as wired USB. Connection-level

security between devices will ensure that the appropriate device is associated and authenticated before operation of the device is permitted. Higher levels of security involving encryption should be implemented at the application level. Processing overhead supporting security should not impose noticeable performance impacts or add device costs.

One of the primary objectives when implementing a wireless interconnect is that it is easy to install and use. Wired connections provide the user with implied expectations, that is that the device is connected as specified by the user when they install the wire. When the wire is installed, the user has basic expectations and when these expectations do not take place (plug does not fit), there is a known recourse.

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.

So WUSB devices installed for the first time should automatically install drivers, security features, and so on and associate with systems that they can interact with. The concepts of 'turn on and use it' with an easy setup procedure will be employed.

WUSB in the Future

The first Wireless USB implementations will likely be in the form of discrete silicon that will be introduced in a number of form factors. These may include add-in cards and dongles along with embedded solutions to support the technology's introduction and subsequent rapid ramp up.

But the wireless future will arrive once WUSB, along with the common ultra wideband platform, becomes a standard part of every processor and chipset and is integrated in CMOS silicon.

Summary

As the latest iteration of USB technology, wireless USB (WUSB) will offer the same functionality as standard wired USB devices but without the cabling. As the new Wireless USB Promoter Group prepares to develop the specifications that will help standardize the technology, the industry is planning products that can take advantage of the convenience and mobility that this new device interconnect will offer