WHITE PAPER

USB Features

- 12 Mb/s bandwidth
- Hierarchical hub-based architecture
- Dynamic device insertion and removal
- 127 device support
- 16-port hub support
- Keyboard/mouse support
- Game device support
- Telephony support
- Audio support

Phoenix USB Support

- PhoenixBIOS™ 4.0
- Phoenix Telephony Suite™
- Phoenix PICO

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Universal Serial Bus

Background

Universal Serial Bus (USB) is a key emerging technology expected to become a market requirement beginning in 1996. Originally proposed by Intel, Microsoft, and other leading hardware vendors, USB is designed to simplify the connection of peripheral devices, provide increased I/O bandwidth, and increase the flexibility of the PC to meet expanded connectivity expectations (see Figure 1).

The primary goal of USB is to eventually replace today's confusing keyboard, serial, and parallel connections with one simple multi-purpose jack, which will automatically detect an attached device and supply appropriate configuration and system support. By providing a way to expand the number of connections through an expandable topology, USB will meet user needs for increasing connectivity. Another goal is to enhance the ease of connecting new peripherals by placing jacks in more convenient locations, not on a possibly difficult to reach back panel of a system chassis, but on a keyboard or monitor near the user.

USB will be successful given industry's simultaneous deployment of host, peripheral, and software support that meets user price and function expectations, and operating system and application support.

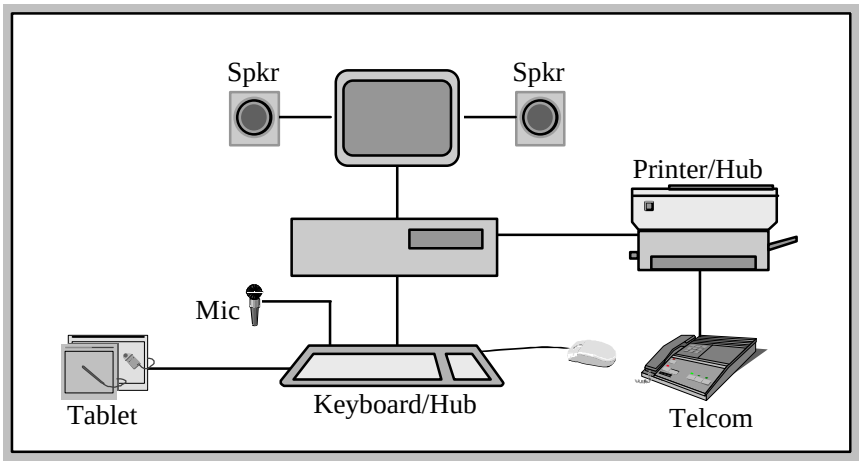

Figure 1 — Sample USB Device Configuration

Phoenix is a major participant in the USB specification process. Currently there are three specification efforts underway: the USB Specification; the Device Framework Specification; and the Open Host Controller Interface Specification. Phoenix has hosted Device Class Specification meetings, and has written the mass storage device class specification, which was actually distributed during the USB Developer's Forum. Mass storage devices include hard disks, floppy disks, CD-ROMs, printers, scanners, and tape devices. Phoenix has remained a active member of the review body for both the USB Specification and the Open Host Controller Specification, working towards a compatible solution for its customers.

Physical Characteristics of USB

USB is a 12Mb/s serial bus with a data rate high enough to support numerous types of devices, including keyboards, mice, joysticks, printers, scanners, speakers, microphones, and floppies. USB will also provide the future interface for telephony into the PC, providing data rates that can support ISDN, POTS, and PBX lines.

The bus architecture is based on a tiered-star topology, with support for up to 128 USB peripherals. Devices attached to the bus are either hubs or peripherals. Hubs, which act like repeaters, are used to branch to other peripherals or hubs. Hubs can support up to 16 ports, with Port 0 attached upstream towards the system.

Power on the bus is limited to 500mA. Because of this limitation, peripherals and hubs fall into two categories: powered and unpowered. In some cases, it makes sense to integrate powered or unpowered hubs into peripherals. For example, printers and monitors (see Figure 1), both powered devices, provide a convenient location for an internal powered hub. On the other hand, an unpowered device like a keyboard will most likely incorporate an unpowered hub. Unpowered hubs limit the number and types of peripherals attached downstream. For example, a keyboard that contains an unpowered internal hub will probably be used to connect simple input peripherals that don't consume much power, like joysticks and mice.

The small and convenient USB connector is only 12.5mm wide (see Figure 2). The cable is physically composed of four wires: Data+, Data-, Vcc (+5V), and GND. Cable length is a function of wire gauge; using 20 AWG the maximum length of the cable is five meters, while 28 AWG wire limits the bus to .86 meters.

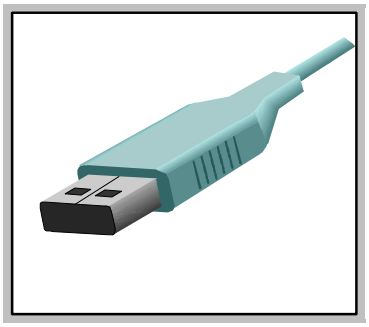

Figure 2 — USB Connector

The USB Peripheral Interface

USB provides a great deal of flexibility by integrating a simple, easy to use connector with sophisticated detection and configuration capabilities, and a data transfer system designed to provide a high degree of expandability.

Logically, USB requires each peripheral to support multiple data streams, called pipes (see Figure 3). Each pipe is connected to an endpoint, which represents a source or destination for a specific data stream. For example, a keyboard may have two data streams: a configuration data stream (Endpoint 0), and a keyboard input data stream (Endpoint 1). All devices must support Endpoint 0, which provides access to the device's configuration information.

In the diagram on the following page, USB clients (drivers and applications) send and receive data through Microsoft's Windows 95 USB Driver (USBD) layer. The USBD layer must also interface to a number of existing APIs, including keyboard, COMM, mouse, parallel, and multimedia. Support for these APIs enables backwards compatibility for existing applications.

USB Enabling Components

- Host chipset support
- BIOS support
- Microsoft USBD support
- Host Controller Interface support
- Peripheral Serial Interface Engine (SIE) support

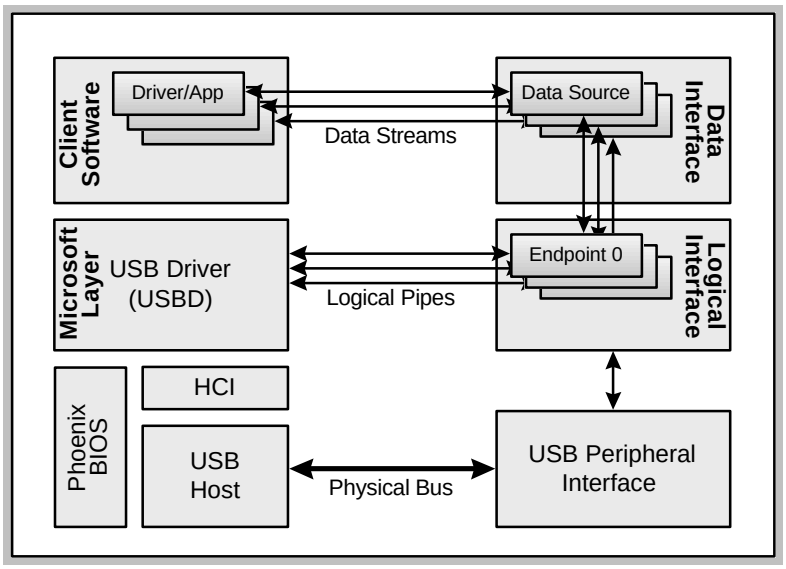

Figure 3 — USB Data Flow Architecture

The USBD layer relies on a common interface to the hardware, called the Host Controller Interface (HCI). This software layer is responsible for mapping hardware-dependent silicon interfaces to Microsoft's USBD layer.

The USB Host contains the physical Serial Interface Engine (SIE) to control the bus. There are currently two interfaces defined between the host and the HCI layer: Intel's Universal HCI Specification, and the Open HCI Specification. The Open Host Controller Interface (Open HCI) specification, written by Microsoft, Compaq, and National Semiconductor, defines a common method by which all manufacturers should design their hardware interface. Both Open HCI and Universal HCI will be supported by Windows 95.

USB's Data Transfer Support

To support various low to mid-speed devices, USB supports four types of data transfers. These data transfer types are designed to accommodate different devices, including keyboards, mice, speakers, microphones, printers, scanners, ISDN and traditional modems.

The following data transfer types are defined by the USB specification:

Control Transfers — Control transfers are used to configure devices and set options. These types of transfers are typically transmitted during bus and device initialization.

Bulk Transfers — Bulk transfers can transmit large amounts of data for printer, scanner, modem, or mass-storage support. Bulk transfers have the lowest priority on the bus, to ensure that Control, Interrupt, and Isochronous transfers have the necessary bandwidth required.

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Interrupt Transfers Interrupt transfers allow transmission of small, irregular data such as that transmitted by human input devices. These devices include mouse and keyboard, as well as game peripherals, drawing tablets, and pens.

Isochronous Transfers Isochronous transfers provide a means to deliver real-time data, such as audio. Data of this type must be delivered in a continuous stream, even at the cost of data integrity. For example, if a data error occurs in an audio stream, it does not make sense to retry it.

Compatibility Issues

USB poses compatibility risks with older operating systems, games, and applications. Many applications designed for DOS 6.x and before access physical hardware interfaces, such as keyboard I/O ports 60h and 64h. Because these applications cannot support USB peripherals without extensive emulation logic, USB support will most likely be reserved for advanced operating systems like Windows 95.

Other compatibility concerns include power utilization and bus bandwidth issues. Overloading the bus could result in insufficient power supplied to unpowered devices. For example, a keyboard containing an unpowered hub may have a difficult time supporting many game devices and other devices like digital cameras simultaneously. For devices that require a sizable portion of bus bandwidth like printers and modems, a user may experience delays in some data transfers. For example, supporting multiple audio streams and an ISDN internet connection simultaneously may cause a document to print more slowly across a USB connection.

Implications for System Manufacturers

USB represents a major convergence of I/O technologies. The goal is to simplify the physical connection of peripherals and to remove configuration concerns from computer users; however, to preserve compatibility, a period of transition is likely, while legacy and USB peripherals coexist in the same system.

Just as Plug and Play cards have not yet replaced standard ISA cards, it will take some time for USB capabilities to offset the advantages (primarily cost, availability) that make today's I/O options attractive to purchasers.

Industry will likely undergo a three phase transition to USB:

Early Phase During this phase users will buy early USB peripherals, which will either include or require a USB add-in controller. In this model, uses will expect their system to support USB add-in controllers and to be able to use new USB peripherals.

Coexistence The transition will begin sometime in 1996, as USB controller capability is provided in core logic and in some peripherals. During this period users will still expect to have the option to use both legacy peripherals, particularly keyboard, mouse, serial and

PhoenixBIOS™ 4.0

- Supports USB
- Universal HCI
- Open HCI
- Incorporates Phoenix Optimal Configuration Technology™
- Supports MultiBoot™

Phoenix USB Consumer Telephony Software Support

- Voice mailboxes
- Caller ID
- Call management
- Credit/calling card
- Speakerphone
- Address book
- Answering machine
- Call screening
- Message archiving/ forwarding
- Remote access

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parallel devices, and gradually add USB-based peripheral support. The major concerns will be in the area of device availability and OS/application compatibility.

Full Acceptance — Eventually, keyboard and mouse support will disappear from the motherboard, as USB peripheral costs drop and support becomes a standard system feature. However, an option will exist to add serial and parallel connectivity through add-in cards.

USB Market Acceptance

Many issues will affect the acceptance of USB in the personal computer marketplace. Among the more important are the following:

Add-in USB Support — BIOS support must be integrated into motherboards today to ensure compatibility with future USB host controllers. The first requirement, to provide for the future integration of USB-based keyboards, should be supported in PCs shipping today. PhoenixBIOS allows limited keyboard support by providing a switch to allow the boot process to function without keyboard detection.

First Silicon — Many manufacturers are designing both host and peripheral support silicon. First silicon will be available from several manufacturers in the Q1 ’96 timeframe. Once silicon is available for add-in controllers and in motherboard chipsets, software support and compatibility testing for various devices will likely require at least another six months before USB can be shipped.

Device Availability — The key to USB success will be the development of cost effective peripherals. At higher price points, modems for example, the incremental cost of USB support may be low. However, for mice, joysticks, and other low cost peripherals, the incremental costs may cause manufacturers to be reluctant to develop and supply USB peripherals.

Full BIOS Support — Once USB has matured, external boot devices like floppy drives, floptical drives, and CD-ROMs will be attached. Because these devices require boot support, PhoenixBIOS 4.0’s MultiBoot™-enabled BIOS will be enhanced to include USB mass storage devices. Optimal Configuration Technology™, a PhoenixBIOS 4.0 feature that optimally configures system settings, will be enhanced to detect and configure both USB host controller interface standards.

OS Driver Support

One factor that will affect USB integration on the motherboard is Windows 95 driver support. The USBD layer will provide USB interfaces to existing drivers, including the keyboard driver, mouse driver, COMM driver, parallel driver, and multimedia driver, to ensure USB device compatibility with existing applications.

Phoenix Telephony Suite™

Once the USBD layer, BIOS support, host silicon, and peripheral support is available, existing and new applications will be able to take advantage of USB-enabled peripherals. The Phoenix Telephony Suite, which supports features like caller ID, call management, voice mailboxes, speaker-phone, speed dial, and much more, will automatically support USB devices like ISDN and V.34 voice-enabled modems.

Phoenix PICO

There are clear applications for serial busses in embedded devices, like point-of-sale terminals, test equipment, medical equipment, military equipment, personal communicators, avionics, and more. Phoenix's PICO group, dedicated to providing system-enabling and system-enhancing software and firmware for the expanding x86 embedded market, foresees USB as an important opportunity for embedded system providers to reduce cost, minimize power requirements, and reduce connectivity form-factors for embedded systems. Most likely USB support will migrate to the embedded market in late 1996 or early 1997.

The Future

USB is the latest in the series of low-speed serial busses, including I^2C, ACCESS.bus, ADB, and GeoPort. What differentiates USB from other low-speed serial busses is its performance, plug-n-play connectivity, and that it has achieved wide endorsement from industry and will be provided as a core component in virtually every major host chipset.

USB, however, does not address the needs for high-speed connectivity to support data streams like compressed video or mass-storage. Although several specifications have been defined that support these data streams, including Fibre Channel, IEEE P1394, and SSA, it is not clear which, if any, will predominate in the future. Just as USB broke out in 1995, 1996 will probably see a large industry push to define a high-speed connection.

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