

USB On-The-Go

Technology and Market Report

October 2003

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PREFACE

USB has emerged as the mainstream input/output technology for desktop PCs, laptop PCs, and a host of peripheral devices. Over one billion USB devices are currently in use, and this number continues to grow.

With device drivers for many USB devices now included in most major operating systems, the plug-and-play feature of USB makes the connectivity of devices easier than ever before. As USB provides end users with a rich user experience, the demand for USB products has substantially increased. Thus the entire USB supply chain benefits from the growth of this technology.

USB On-The-Go (OTG) will extend the advantages of plug-and-play to consumer electronics products, benefiting a host of portable devices, including PDAs, cell phones, cameras, and many other devices that need to connect directly to other USB OTG devices. Given the success of USB, there is great market potential for USB OTG products.

The new *USB On-The-Go Technology and Market Report* outlines the vast market potential of USB OTG and provides a detailed forecast of each product category. By providing a detailed snapshot of this new market, this valuable resource provides critical information that will enable USB developers and marketers to stay competitive.

*Jeff Ravencraft
Technology Initiative Manager, Intel
Chairman, USB Implementers Forum*

RECOMMENDATIONS FROM INDUSTRY LEADERS

"The new *USB On-The-Go Technology and Market Report*—the result of a joint research effort between Tech Idea International and the USB OTG Working Group members—is a valuable resource for USB OTG developers and providers who need the most up-to-date information in the fast growing USB OTG handheld and mobile phone markets."

Terry Remple
Co-chair
USB OTG WORKING GROUP

"At Philips we're very committed to USB OTG, as evidenced by our USB OTG hosts, bridges, and transceivers. We find the *USB On-The-Go Technology and Market Report* to be a very relevant source of information on the growing USB OTG market."

David Sroka
International Marketing Manager
Wired Connectivity Product Line
PHILIPS SEMICONDUCTORS

"Tech Idea International's comprehensive research delivers what it promises—relevant, reliable, and accurate data that provides the level of insight only an industry insider is able to offer. USB developers and OEM manufacturers alike will greatly benefit from the information presented in the *USB On-The-Go Technology and Market Report*."

Jeff Chang
Director of Marketing
CYPRESS SEMICONDUCTOR

"As a major player in the USB OTG market, TransDimension recognizes the importance of staying informed about the market trends and development of USB OTG. The *USB On-The-Go Technology and Market Report* provides vital marketing information needed by the USB OTG community."

David Murray
Vice President
TRANSDIMENSION

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INTRODUCTION

OVERVIEW

USB ports have been installed in almost all new PCs since 1999, with drivers for many peripheral devices included in operating systems since the introduction of Microsoft Windows XP. USB is now truly universal, providing an unprecedented level of plug-and-play capabilities.

The growth of the consumer electronic device market has increased the need for the peer-to-peer feature that is lacking in the original USB specifications. To address this need, the USB-IF has created a working group to develop and deploy USB On-The-Go (OTG), which supports the peer-to-peer and low-power features needed by the growing number of consumer electronic devices.

REPORT OBJECTIVES

Our goal in publishing this report is to provide the most comprehensive source of information about the latest technical developments and market trends in the USB On-The-Go technology. The report will provide an overview of the technology, a market analysis, and a five-year forecast. This report also attempts to answer these questions:

- What is USB OTG?
- What are the key features and characteristics of USB OTG?
- What are the main applications of USB OTG?
- Are there alternative solutions that could potentially replace USB OTG?
- Who are the key players in the USB OTG market?
- What are the forecasted trends for the USB OTG market?
- How long will it take before USB OTG becomes mainstream like USB 2.0?
- What is the growth potential of USB OTG?
- Where are the market segments with high potential?

RESEARCH TEAM

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Tech Idea Research

John Koon is an industry analyst, covering new and emerging technologies like USB, IEEE 1394, wireless, digital home, and UPnP. He has been active in the development and marketing of USB technology since its inception.

As a USB consultant, John advises USB product suppliers on strategy and product development. In this role, he has been active in USB Developers Conference and PlugFest events since 1996. In addition, he has spoken on USB at several events, including the California Computer Expo, San Diego Computer Society, PC Developers' Conference (in the U.S. and Europe), and Technology Locator Round Table.

John has written "USB Peripheral Design," and several technology papers. He holds a BSEE degree from California Polytechnic University, Pomona, and an MBA from San Diego State University.

René Williams
Marketing Consultant
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René Williams is a business and technology writer who provides an extensive range of marketing services to global high-tech clients. René specializes in the research of development of strategic marketing plans, product brochures and data sheets, end-user documentation, press releases, articles, and newsletters, web copy, white papers, case studies, and customer presentations. René has written about the USB market and USB products since 1997.

René holds a BA in communications from California State University, Fullerton, and an MBA from Pepperdine University.

RESEARCH METHODOLOGY

The forecasts compiled and presented in this edition of the *USB On-The-Go Technology and Market Report* is based on a combination of primary and secondary research. The primary research consists of a market survey of member companies of the USB OTG Working Group, and interviews with USB OTG experts from many leading USB providers. The secondary research was conducted using print and electronic sources, including industry journals and web sites.

USB OTG EXPLAINED

WHAT IS USB OTG?

The USB OTG specification is a supplement to USB that is designed to provide the portability and low-power features needed by the growing number of consumer electronic devices, such as digital cameras, personal digital assistants (PDA), cell phones, and portable audio players. A standard, easy-to-use interface for desktop and laptop PCs, USB enables connectivity from a USB host to another USB host or peripheral device. USB OTG takes this interface to the next level, enabling consumer electronic devices to connect to each other, without the need for a host PC. USB OTG takes advantage of USB's ease-of-use—a key feature for consumer electronic devices, which typically are used by less tech-savvy consumers.

As USB OTG is a supplement to USB, the new USB OTG devices will be able to connect easily to the existing one billion (estimated) USB products on the market.

Figures 1 and 2 illustrate USB OTG in its simplest form.

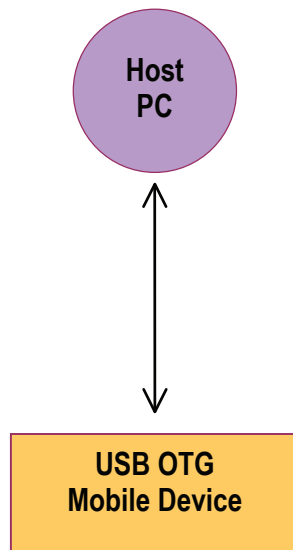


Figure 1.
OTG device will act as a slave when connected to the host PC.

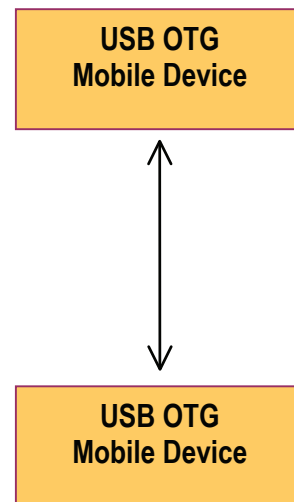


Figure 2.
Each OTG device can be a host or a device.

A Brief History

In 1994, seven core companies defined USB as a universal, simple interface between phones and computers. Once defining the specification was in process, these original participants formed the USB Implementers Forum (USB-IF), which currently boasts more than 1,000 members. Now known as The USB-IF, Inc., the group's board of directors comprises representatives from Agere Systems, Hewlett-Packard Company, Intel Corporation, Microsoft Corporation, NEC Corporation, and Philips.

Since the birth of USB, computers have become much smaller, more portable, and more pervasive, and the consumer electronics industry has grown at an amazing rate. Desktop PCs have given way to notebook PCs, portable PCs and now palmtop PCs. The original "portable" cellular telephones (a small box with big battery) have been replaced with tiny cellular phones that provide a multitude of functions. Even camcorders have reduced in size, so that consumers can carry a camcorder in the palm of their hands.

In addition to the changes in existing products, a number of new consumer electronic devices have appeared on the market. Intelligent handheld devices, like the Palm handheld, and the Microsoft CE-based Personal Digital Assistant (PDA), first appeared, requiring only an interface requirement that enabled connection to a PC to synchronize the address book and daily appointments. With these simple interface requirements, PDAs used infrared (IR) or serial interfaces using a dongle or cradle. However, as consumers demand easier ways to connect these devices, USB has become the interface of choice. Other portable consumer electronic devices—MP3, digital recorders, digital cameras, and photo printers—are now available, requiring a much more robust interface to perform such functions as music and photo file downloads,

As more and more consumer electronic products are introduced, the obvious challenge is find the optimum method for connecting the devices together, preferably without a PC. Many vendors have designed their own interface methods, many of which have relied on a cradle designed to hold the device with a serial or USB cable connected to the PC, and a separate connection to the AC adapter. Needless to say, the drawback of the cradles is that they are designed to work only with a specific brand, and often with a specific model. For instance, a cradle designed for Hewlett-Packard's iPAQ will not work with the Sony Clié. When we consider that these new devices need to exchange large files containing music, data, and even video, the challenge becomes greater.

The goal of the USB OTG Working Group is to create a standard, like USB, that uses a simple cable and miniaturized connectors that will fit comfortably into the new smaller sized devices. Also, for a USB OTG device to connect to other devices without the use of a PC will require the peer-to-peer capability, much like that in IEEE 1394. As this feature is lacking in USB 1.1 and 2.0, the USB OTG workgroup has incorporated this feature to the USB OTG standard.

USB OTG will simplify the interconnection of these small devices as one cable will connect between all USB OTG devices, which will work together much like USB. Thus, USB OTG will enable consumers to print photos directly from a camera, and sync data with a PC or other back-up unit. The ability to connect to many different accessories also will benefit consumers, who will have a greater selection of devices. For example, a PDA keyboard with a USB OTG interface will be compatible with any brand PDA with a USB OTG interface.

With the connectivity benefits and the streamlined components, the USB OTG solution will simplify life for users of consumer electronic devices, while enabling manufacturers of these devices to reduce the cost of production. The challenge, of course, is for all the manufacturers to follow the USB OTG specification to ensure compliance.

One of the goals of USB OTG is to standardize the PDA connection by replacing the cradles with proprietary connectors on one end and a USB connector on the other end with a simple USB OTG cable. Another goal is to enable cell phones to connect to other data devices with a USB OTG interface.

APPLICATIONS ANALYSIS

USB OTG supports numerous applications for consumer electronic devices. The list of potential applications shown in Table 1 was presented by the USB OTG Working Group at a recent developer's conference in Japan. This list represents the perspective of the USB OTG Working Group. However, as several competitive technologies also can be used for many of these applications, it is important to identify the interface methods that may be preferred for any given application. Therefore, this information is provided in Table 2.

TABLE 1. POTENTIAL APPLICATIONS FOR USB OTG

DEVICE	CONNECTED DEVICES	SAMPLE APPLICATIONS
Mobile Phone	Mobile Phone	Exchange contact information
	Still Image Camera	Email pictures Upload pictures to web
	MP3 Player	Upload/download broadcast music
	Mass Storage	Upload/download files
	Scanner	Scan business cards
Still Image Camera	Still Image Camera	Exchange pictures
	Mobile Phone	Email pictures Upload pictures to web
	Printer	Print pictures
	Mass Storage	Store pictures

DEVICE	CONNECTED DEVICES	SAMPLE APPLICATIONS
Printer	Still Image Camera	Print pictures
	Scanner	Print scanned images
	Mass Storage	Print files stored on device
MP3 Player	MP3 Player	Exchange songs
	Mass Storage	Upload/download songs
AutoPC	MP3 Player	Play audio in car
	Mobile Phone	Hands-free over stereo
PDA	PDA	Exchange files
	Printer	Print files
	Mobile Phone	Upload/download files
	MP3 Player	Upload/download songs
	Scanner	Scan pictures
	Mass Storage	Upload/download files
	Still Image Camera	Upload pictures
	GPS	Obtain directions and mapping information

TABLE 2. PREFERRED INTERFACES FOR POTENTIAL USB OTG APPLICATIONS

ENVIRONMENT	CONNECTED DEVICES	INFORMATION EXCHANGE	PREFERRED METHOD
Office			
	Desktop PC to notebook or palmtop PC	Work files (Word, Excel, etc.).	Ethernet network via server or network software.
	Desktop or notebook PC to PDA or smart phone	Synchronization of contacts and appointments, and limited downloads of maps, images and work files. PDA will most likely not be used to handle large files.	Current method is USB or IR. Future choices will be USB, USB OTG, Bluetooth, and 802.11x.

ENVIRONMENT	CONNECTED DEVICES	INFORMATION EXCHANGE	PREFERRED METHOD
Home and Entertainment			
	Desktop to digital audio or TV (digital home concept as promoted by Intel -- see www.intel.com/technology/digitalhome)	Songs, movie, and photos.	Digital media adapter, such as advanced DVD, with 802.11x and Ethernet interface.
	Internet, desktop and notebook PCs to PDA, MP3, and PED	Music download.	USB OTG and 802.11x are strong contenders as both provide sufficient speed. 802.11x ranges from 11 to 54 Mbps and USB OTG ranges from 12 to 480 Mbps. Wireless will be the preferred method as it is more convenient to use. Even with its future 16 Mbps speed, IR will probably not be a choice as its line of sight requirement is less convenient. Bluetooth in its current state does not provide the needed bandwidth.
	Desktop to PDA, PED, and mobile phone	Photo exchange.	USB OTG, Bluetooth, and USB cradle could be used.
	PDA, mobile phone, and digital camera to photo printer	Photo printing.	USB OTG and IR will be the preferred interfaces. However, Bluetooth could be used.

ENVIRONMENT	CONNECTED DEVICES	INFORMATION EXCHANGE	PREFERRED METHOD
AutoPC			
	Built-in, embedded device	Sending commands to a dashboard console to download emails, select songs, etc. Obtain GPS information.	Voice I/O.
	Mobile phone to built-in intelligent embedded device	Synchronization of address book.	USB OTG, Bluetooth, and IR are possible choices. Bluetooth and USB OTG currently have development efforts for this application with Bluetooth phones now available. Qualcomm is pushing the development of autoPC to USB OTG and has introduced a USB OTG car kit reference design for use by automakers.
Payment and Shopping			
	Mobile phone or PDA to vending machines	Purchasing items from vending machine, and using digital dollars to shop.	Bluetooth and IR are preferred methods as a wireless interface is more convenient. However, security issues need to be addressed.
	Mobile phone or PDA to payment machines	Pay with digital dollars and receive digital receipt from establishments such as restaurants, parking lots and for tolls.	VISA supports the use of such methods with mobile phones with built-in IR. This application is popular in Korea and Japan. Bluetooth is another option, but security needs to be addressed. As a wired interface, USB OTG will not be used.

FEATURES AND CHARACTERISTICS

The USB On-The-Go supplement to the USB 2.0 specification was first released in 2001, and then revised on June 24, 2003 as Revision 1.0a. This document, a supplement to the original USB specification, does not exist as a standalone document.

The USB OTG supplement adds the peer-to-peer feature, which was not previously part of the USB specification. The supplement also defines a smaller connector that is more suitable for consumer electronic devices, such as the PDA, and digital cameras. Unlike the PC and large peripheral devices that can use a standard-size USB connector, these smaller, portable devices require a connector with a smaller footprint.

The compliance plan and the test procedure for USB OTG were released in 2003. Many key companies contributed to the creation of these documents, including: ACON, ARC, Aten, Cypress Semiconductor, Ericsson, Hewlett-Packard, Imation, InSilicon, Intel, Lumberg, Maxim, MCCI, Mentor Graphics, Microsoft, Molex, Motorola, NEC, Nokia, Onspec, Palm, Philips, Qualcomm, SoftConnex, Texas Instruments, TransDimension, and Tyco Electronics.

This section includes a description of each of the features provided with USB OTG.

Peer-to-Peer Capability

The most important feature in USB OTG is the addition of the peer-to-peer capability. In the original USB specification, a host PC connects up to 127 devices and acts as the only control in the configuration, so that every task involves the PC. For example, to print a photo, a user must first transfer the image to the host PC, then send the file to the printer. This is typically performed by downloading the image to the PC, or transferring the image to the PC through the removable memory card.

Using the peer-to-peer capability, a USB OTG device can be connected directly to another USB OTG device, completely bypassing the PC. For instance, a USB OTG camera can be connected directly to a USB OTG printer to print images. In this example the camera acts as a host.

Since USB OTG applications are usually simpler than a host PC to device connection, the USB OTG device has a dual function, but with limited host capability. The peer-to-peer connection also can be viewed as a point-to-point connection without a PC. Since OTG is part of the USB specification, all USB OTG devices can be connected to the host PC as in the USB 1.1 or 2.0 application.

Speed

USB OTG supports both the full-speed of 12 Mbps and the low-speed of 1.5 Mbps. High-speed support of 480 Mbps is optional. This means that USB OTG devices are required to support the 12 Mbps speed, but also may support the faster 480 Mbps as devices like digital cameras and camcorders will require higher speeds.

Smaller Connectors

A smaller footprint, mini AB connector will be installed in each USB OTG device. Unlike standard USB devices in which multiple USB type A connectors may be installed (as in the case of a desktop PC), only one mini AB may be installed on a USB OTG device. For the connector specification, go to <http://www.usb.org/developers/onthego/>.

Power

USB OTG requires a minimum of 8 mA, with a maximum of 500 mA from the VBus.

Communication Methods

USB OTG has further defined USB hardware into three types of devices, each with a different function: 1) *A device*, 2) *B device*, and 3) *Dual-role device*. Each developer must determine to which category a certain USB OTG device will belong.

- An *A device* is usually a desktop or notebook PC which must be able to respond to Session Request Protocol (SRP). SRP is the mechanism built into USB OTG to allow a device to initiate communication with other devices. With SRP, bus power can be turned on and off.
- A *B device* is usually a standard USB peripheral such as a USB printer that is already on the market. This type of device will initiate SRP.
- A *dual-role device* is a USB OTG device that must be able to both initiate and respond to SRP. USB OTG cameras and PDAs are examples of dual-role devices.

As each USB OTG device can act as either a host or a device, there is a need to decide which device will be the host at any point in time. Dynamic switching between the host and device will occur using the Host Negotiation Protocol (HNP). This determines which device will be the host when two USB OTG devices are connected.

Device Classes

USB 2.0 defined 16 device classes. USB OTG can be a subset of any of the device classes; however, its support has not yet been fully defined.

COMPETING TECHNOLOGIES

USB OTG is one of several networking technologies that can be used as the interface between consumer electronic devices. These networking technologies, which include both wired and wireless interfaces, compete with USB OTG for use on these devices. The most popular wired networking technologies include Ethernet (10 Mbps), Fast Ethernet (100 Mbps), and HomePNA. Leading wireless networking technologies include IR, IEEE 802.11x (wireless Ethernet), and Bluetooth.

In addition to these networking technologies, USB OTG competes with IEEE 1394, proprietary interfaces and the serial interface. With the exception of the proprietary and serial interfaces, which will most likely be phased out over time, these interfaces and their relationship to USB OTG will be discussed in this section:

- Bluetooth (wireless)
- Ethernet/Fast Ethernet
- HomePNA
- IEEE 1394
- IEEE 802.11x (wireless)
- Infrared (wireless)
- Proprietary
- Serial

Bluetooth

TECHNOLOGY DESCRIPTION

Bluetooth, a royalty-free, wireless technology, uses a 2.4 GHz radio frequency and provides interference immunity by hopping among 79 frequencies at 1 Mhz intervals 1600 times per second. The Bluetooth specification supports both data and voice.

Bluetooth technology, which includes a security feature, has gained momentum around the world. Currently, the IEEE committee is working to include a Bluetooth specification. Bluetooth has great potential and is a strong competitor to infrared for in-sync payments and other simple transactions.

Information about Bluetooth and the Bluetooth Special Interest Group (SIG) can be found at <http://www.bluetooth.org>.

SUMMARY OF SPECIFICATIONS

Speed:	The data channel can perform as an asymmetric link or symmetric link. As an asymmetric link, data can be sent in either direction at a maximum speed of 1 Mbps with an effective data rate of 723.2 kbps. The return direction is at 57.6 kbps. The symmetric link will perform at 433.9 kbps.
Protocol:	Supports three different modes: (1) one asynchronous data channel, (2) a maximum of three simultaneous synchronous voice channels, and (3) a channel with one asynchronous data and synchronous voice. Additionally, each voice channel supports a 64 Kbps synchronous link in each direction.

RELATIONSHIP WITH USB OTG

Bluetooth supports a lower speed than USB OTG and focuses on short-range wireless applications, such as email downloading to a cell phone. Like USB, Bluetooth functions in a master/slave mode. However, with USB, the host PC is always the master.

With its support of higher speeds, USB OTG will be used over Bluetooth for most consumer electronic device-to-device connections, and for large file downloads. However, for simple transactions, Bluetooth will be the most likely winner.

Ethernet (10 MBPS) and Fast Ethernet (100 MBPS)

TECHNOLOGY DESCRIPTION

Ethernet, also called IEEE 802.3, is one of the most popular wired networking technologies. The most common speeds for Ethernet are 10 Mbps (Ethernet) and 100 Mbps (Fast Ethernet). Often, both speeds can be used together through the use of an adapter. A new Ethernet supporting 1 Gbps is currently in development.

Although a constantly evolving technology, Ethernet is one of the most mature networking technologies—having become an IEEE standard in 1995. Ethernet technology began with the original ThickNet (10Base-5) and ThinNet (10Base-2), which require shielded cables. The current version of Ethernet uses Cat. 5 unshielded twisted pair (UTP), which has replaced the older versions of ThickNet and ThinNet.

SUMMARY OF SPECIFICATIONS

Speed:	10 Mbps (10Base-T) or 100 Mbps (100Base-T) Gigabit Ethernet is now becoming available.
Protocol:	IEEE 802.3 Carrier Sense Multiple Access with Collision Detection (CSMA/CD)
Distance:	100 meters (328 feet) for 100 Base-T
Operating Systems Support:	Microsoft Windows 98/2000/XP/CE, Linux

RELATIONSHIP WITH USB OTG

Ethernet is not a direct competitor to USB OTG. Both USB and Ethernet are built into desktop PCs and most laptops; each serving a different application. For non-mobile applications, such as the network backbone, desktop and laptop PCs will continue to use Ethernet to share files and exchange information. Consumer electronic devices, however, will lean toward USB OTG. Today, several manufacturers provide USB to Ethernet adapters.

HomePNA

TECHNOLOGY DESCRIPTION

HomePNA (Home Phone Network Alliance), which supports up to 10 Mbps, makes use of a phone line in the home to network together computer products. As no new wiring is needed with HomePNA, new homebuilders are encouraged to include HomePNA in new construction.

SUMMARY OF SPECIFICATIONS

Speed:	10 Mbps (real throughput is about 2 to 3 Mbps)
Protocol:	Ethernet (1 Mbps and 10 Mbps)
Operating System Support:	Microsoft Windows 98/2000/XP, Apple Mac OS 8.6/9.0
Connector:	RJ-11 (two-wire) for phone line RJ-45 (four-wire) from the network side

RELATIONSHIP WITH USB OTG

HomePNA competes with Ethernet in the home networking environment rather than with USB OTG as the technologies serve different applications. A few vendors will offer USB OTG to HomePNA adapters.

IEEE 1394

TECHNOLOGY DESCRIPTION

Invented by Apple, IEEE 1394 (also known as "FireWire") currently supports up to 63 devices at speeds up to 400 Mbps. The 1394 Trade Association is working on increased speeds of 800 Mbps and 1.2 Gbps.

IEEE 1394 is used primarily in consumer electronics that require a high-speed interface, such as camcorders, surround sound controllers, audio recorders, videoconferencing equipment, and cameras, and some printers/scanners.

Information about IEEE 1394 can be found at www.1394ta.org. The 1394 Trade Association has a membership of about 160.

SUMMARY OF SPECIFICATIONS

Speed:	393 Mbps (S400) 197 Mbps (S200) 98 Mbps (S100)
Protocol:	Peer-to-peer, hot plug and play
Distance:	4.5 meters between devices (S400) 14 meters (S200 and slower)
Operating System Support:	Microsoft Windows 98/2000/XP, Apple Mac OS 8.6/9.0

RELATIONSHIP WITH USB OTG

USB OTG is a peer-to-peer protocol that supports speeds up to 12 Mbps, with optional 480 Mbps. As a low-speed interface (1.5 Mbps), USB OTG does not compete with IEEE 1394, which supports a much higher speed (400 Mbps). However, with the high-speed support of 480 Mbps—faster than that supported by the current IEEE 1394—high-speed USB OTG is a strong competitor to IEEE 1394. This means that USB OTG will potentially steal market share of some Japanese-made digital camcorders and cameras where IEEE 1394 has traditionally been a popular interface.

The new IEEE 1394 specification of 800 Mbps will compete in the non-USB, high-end server and storage market segments. Eventually, USB (not USB OTG) and IEEE 1394 will carve out their own markets, with USB owning most of the PC and consumer segment of 480 Mbps or lower, and IEEE 1394 garnering the video related and high-end segment of 480 Mbps and higher. This means that IEEE 1394 will take the lead in the home video and audio segment, which includes digital video camcorders, audio equipment and digital TVs.

IEEE 802.11X

TECHNOLOGY DESCRIPTION

IEEE 802.11x is an extension of the IEEE 802.11 wireless Ethernet standard that increases the speed of Ethernet from 11 Mbps to 54 Mbps.

Information about IEEE 802.11x can be found at <http://www.ieee.org>.

SUMMARY OF SPECIFICATIONS

Speed:	11 Mbps, 22 Mbps, 54 Mbps
Protocol:	2.4 GHz RF, optional 128-bit encryption
Distance:	Up to 46 meters (150 feet)
Operating System Support:	Microsoft Windows 98/2000/XP, Apple Mac OS 8.6/9.0, Linux

RELATIONSHIP WITH USB OTG

IEEE 802.11x is a potential competitor to USB OTG. Although wireless IEEE 802.11x does not share power or source power, it has other advantages over USB OTG. For instance, IEEE 802.11x is wireless and supports sufficient speeds, and most users prefer wireless data exchange to wired interfaces.

Infrared

TECHNOLOGY DESCRIPTION

An infrared (IR) link is used by many handheld computers and laptop PCs. Typically IR is used to synchronize handheld computers with laptop or desktop PCs, though most PCs require an external IR device. Typical devices using infrared include laptop PCs, handheld computer, some cell phones, printers, and cameras. Applications include sending documentation to a printer (somewhat undesirable), and syncing between devices like PDAs and PCs, which is most widely used. New applications include designing infrared as part of mobile phone for digital payment. This application is supported by VISA, and is beginning to become popular in parts of Asia, including Japan and Korea.

Infrared uses line of sight for two devices to communicate. This means that the objects must be in a straight line with one another, with no blocking object.

Information about the Infrared Data Association (IrDA) can be found at <http://www.irda.org>. The IrDA has a membership of about 100.

SUMMARY OF SPECIFICATIONS

Speed:	9600 Kbps, 115 Kbps and 4 Mbps (with a future speed of 16 Mbps)
Protocol:	Bi-directional with some data check using CRC (cyclical redundancy check protocol)
Distance:	Typical 1 to 2 meters. Low power version supports up to 20 cm with a maximum speed of 115 Kbps. Connection must be a straight line without obstacle in between (line of sight).
Operating System Support:	Microsoft Windows 98/2000/XP/CE, Linux

RELATIONSHIP WITH USB OTG

USB and IR will co-exist comfortably for a few more years. Most desktop PCs offer USB, most laptops offer both USB and IR, and most handheld devices offer IR only. Due to its higher speed, USB OTG will be the preferred method for portable consumer electronic device connections. Also, the line of sight requirement for IR can unnecessarily restrict applications like music download. It is important to note that while the cost of USB OTG is expected to be \$3 to \$5 per connection, IR will remain close to \$1.

USB OTG is predicted to become the dominant interface for mobile consumer electronic devices. IR will dominate in some market segments, like digital payments, when USB OTG will not be used. Therefore, to meet the need of USB to IR, a few companies have introduced USB to IR converter products. Given the growth of IR, it is likely that more companies will begin to offer converter products.

THE USB OTG MARKET

USB AND USB OTG TODAY

Today USB ports are available in every PC and laptop, and will be included in the new tablet PCs. USB has become the interface of choice for peripheral developers due to its auto-configuration and ease of use features. More and more new products include USB: industrial single-board computers all have USB, and peripherals such as printers, storage devices, 6-in-1 readers (many forms of flash memory cards), MP3 players, and digital cameras all use USB. Even floppy drives are being replaced by USB flash memory devices, which come in many different forms like key chains and wristwatches. With the introduction of 480 Mbps USB 2.0, the interface is now used for external storage devices such as CD/RW and DVD. Indeed, USB provides a very effective way for any electronic devices to connect to PCs.

USB OTG, a natural extension of USB, makes it is easier than ever before for consumer electronic devices to connect with a host PC, and with each other. As new consumer electronic products appear on the market, the demand for this type of interface grows.

There is no doubt that USB OTG offers several advantages over many other interfaces; however, it remains to be seen how USB OTG will coexist with the other interfaces as they all compete for the limited real estate of the small, mobile consumer electronic devices.

Announcements about USB are typically made at the Intel Developer Forum (IDF), which is the platform used to promote USB. It is interesting to note that it was evident at the IDF held in San Jose, CA in mid-September that USB has become a mainstream technology; therefore, it no longer attracts the spotlight it once did. The general feeling from Intel is that USB is now mainstream and does not require the same promotion it needed when it was first introduced.

FACTORS IMPACTING THE GROWTH OF USB OTG

It is important to understand the factors that will impact the growth of USB OTG, today and in the future. The section identifies both the positive factors that will facilitate the growth of this interface, as well as the negative factors that will work against USB OTG.

Positive Factors

LARGE EXISTING INSTALLED BASE

The large USB installed base uniquely benefits USB OTG. With an estimated one billion USB connectors installed today, USB has a large presence. Because of the universal approach, new USB OTG devices can easily connect to a host PC and to other devices. Additionally, the experience of the USB-IF has helped USB OTG developers to bring products to market more quickly.

USB OTG WORKING GROUP CREATES MOMENTUM

A subgroup of the USB-IF, the USB OTG Working Group is very motivated to promote the technology to developers worldwide. Qualcomm, a member that supplies about 20% of the silicon to cellular phone handset manufacturers worldwide, is creating USB OTG car kits and actively promotes USB OTG as the solution for the connection of cellular phone to other USB OTG devices, including autoPC.

Although the USB OTG Working Group has created momentum in the community, not everyone is convinced that USB OTG is an important solution. Apple, for example, is a strong proponent of IEEE 1394 and has not been a supporter of USB OTG. Still others argue that Bluetooth is a better solution over USB OTG for the connection of cellular phones to PCs and vending machines for making purchases.

HEALTHY INFRASTRUCTURE

USB OTG also enjoys the healthy infrastructure created by USB, which will benefit USB OTG developers. This infrastructure includes a community of USB-IF member companies that have contributed to and now actively promote USB, and will use their expertise to develop and promote USB OTG.

The USB OTG Working Group comprises 30 member companies that work together to provide the building blocks of USB OTG, enabling device manufacturers to easily produce USB OTG devices.

The following is the list of players leading the drive for USB OTG. The most active members are: Cypress, Philips, and TransDimension.

IP companies include:

ARC International - www.arc.com

ARM Inc. - www.arm.com

InSilicon - www.insilicon.com

Mentor Graphics - www.mentor.com/inventra

SoftConnex - www.softconnex.com

TransDimension - www.transdimension.com

Silicon vendors include:

Cypress Semiconductor - www.cypress.com
Intel - www.intel.com
Maxim - www.maxim.com
Motorola - www.motorola.com
NEC - www.nec.com
Philips - www.philips.com
Qualcomm - www.qualcomm.com
Texas Instruments - www.ti.com
TransDimension - www.transdimension.com

Software vendors include:

Microsoft - www.microsoft.com
MCCI (driver and consulting) - www.mcci.com
Onspec - www.onspec.com

Hardware vendors include:

ACON (connectors) - www.acon.com/English/
Aten (devices) www.aten.com
Ericsson (cellular phones) - www.ericsson.com
Hewlett-Packard (PDA and imaging devices) - www.hp.com
Imation (storage and devices) - www.imation.com
Lumberg (connectors and cables) - www.lumberg.com
Molex (connectors and cables) - www.molex.com
Nokia (cellular phones) - www.nokia.com
Palm (PDAs) - www.palm.com
Sony (PDA and devices) - www.sony.com
Tyco Electronics (connectors and cables) - www.tyco.com

Facilities for USB and USB OTG testing include:

MCCI - www.mcci.com
NSTL - www.nstl.com
NTS - www.xxcal.com
PMTCT - www.pmtctest.com/hwtest

More than one IP company is currently selling software core to silicon manufacturers and several silicon manufacturers are shipping products today. Although only a few vendors are currently shipping devices, the USB OTG Working Group is hoping to see USB OTG devices available on the market for the 2003 holidays.

INCREASE IN SIZE OF TARGET MARKET

USB was introduced as a PC-centric solution, with the focus on PC to peripheral connections in the office and at home. The target audience for USB OTG shifts the focus from PC users to users of consumer electronic devices. While the overall shipments of PCs and peripheral products are about two to three hundred million per year, the shipments of consumer electronic devices can reach two to three times that number. This increased market size is a positive motivator for manufacturers who are considering producing USB OTG products around the world.

To add to this number, many users of consumer electronic products upgrade their devices more often than PC equipment as new feature-rich, more stylish devices are introduced. Also, as skilled jobs like those in design, production, and technical support are moved to places like China and India, more workers will begin to purchase consumer electronic devices that were previously not affordable. As a result, the world market for USB OTG will include Asia and India, in addition to the western industrial markets. As more and more consumers desire mobile products, USB OTG will benefit from the large market size.

USB IS NOW TRULY UNIVERSAL

With the introduction of Microsoft's Windows XP, USB has enjoyed another level of true plug and play. Most USB drivers are now included in Windows XP simplifying the connection of USB devices. Devices like the popular USB flash memory product, which is touted as the replacement of the floppy drives by many of the PC vendors, does not need any driver and works the first time it is connected to a PC with Windows XP. Linux also has been included by most of the USB hardware vendors. It is expected that USB OTG will follow this same path as USB to be included in Windows and other operating systems from 2004.

Negative Factors

WORLD ECONOMY

The recovery of the world economy will continue to be slow. With the lifting of the SARS ban, the Asian market will become more active. Even though both China and India will be growing faster than the rest of the world, it will take more than two countries to create a good economy. It is expected that the world economy will take at least two years before it's back to pre dot com levels.

MANY ALTERNATIVE TECHNOLOGIES

Mobile products will be one of the fastest growing product segments. To be truly mobile, however, consumers will prefer wireless connections in most cases, except when power and high-speed connectivity is needed. Many wireless technologies are competing for this market space. Wireless standard IEEE 802.11x offers speeds up to 54 Mbps and is the preferred method at home. While Bluetooth is much slower, a few minutes may not make much difference for a user for applications like simple address book download from other devices including PC.

In deciding on a technology, the consumer will be subject to tradeoffs, between level of convenience; wired versus wireless, acceptable speed for certain connections, and availability of services in certain locations.

MARKET TRENDS

Consumer electronics market is growing

For the past 30 years, PCs have led the growth of the electronics industry. First PC hardware shipments grew, followed by peripherals and networking products. With the advance of embedded electronics allowing for greater functionality, smaller sizes, and lower costs, consumer electronics are now the growth segment in the electronics industry.

With the growth of consumer electronics, most of the expenditures are coming from consumers, rather than corporate buyers. Consumers are spending more and more money on portable consumer electronic products like digital cameras, MP3 players, digital recording devices, and smart mobile phones. MP3/flash memory/digital recorders, 256 MB flash memory in a watch, and cellular phones with built-in camera are just the beginning. While PC shipments are approximately 100 million units a year along with a few hundred million units of peripheral products, the shipment of consumer products will be many times of those numbers.

This trend is important to providers of consumer electronics as consumers behave differently from corporate buyers in that the former makes decisions based on want rather than need. Consumers also make new purchases to replace existing device simply because the device may be out of style. In fact, many Asian companies now design different versions of electronic devices for men and women.

Target audience for consumer electronics is changing

Adults are the main decision-makers for the purchase of PCs and peripheral devices. With the introduction and growth of entertainment and communications products, however, many of the purchase decisions for these devices are being made by teenagers and young adults. This means that the

profile of the buyers is changing and the number of buyers is increasing. Therefore products that are easy to set up and use—like USB OTG—will be more desirable than those that are not.

Products are becoming smaller and portable

Consumer electronic devices are continuing to decrease in size, as consumers demand smaller and portable products. Cell phones are now pocket-sized, cameras are smaller and lighter, with more functions, and MP3 players are more compact, but can store more songs.

With this reduction in size, these devices will require an interface that is scaled to the size and function of the device. This demand will benefit both wireless and wired technologies like USB OTG. (For additional information, see *Product Trends*.)

Consumption will increase in Asia

Many companies have been outsourcing design and technical support functions to Asia, specifically to China and India. In fact, a major silicon company has recently opened two design centers in Asia: one near Shanghai, China, and one in India. With this influx of new jobs in this region, more workers will have larger disposable income to spend on consumer electronic products. This is especially important as the combined population of China and India is about two billion, roughly half of the world's total population.

PCs will become servers

With the advance of embedded electronics, PCs will take on many different forms. This will include the traditional desktop, various sizes of laptops, palmtops, tablets, industrial, and compact PCs. PCs also will include the handheld PDA, smart phones, and anything in between. The new trend is to use many electronic devices that connect to the PC either via cable including USB/USB OTG or a wireless interface. Rather than being replaced, the desktop PC becomes a server as described in the Digital Home concept promoted by Intel.

Standardization will provide shorter time to market

Many new technology initiatives have been started, resulting in several new standards like wireless IEEE 802.x, UPnP (Universal Plug and Play), or USB/USB OTG. The trend to standardization has shortened the time to market for many product designs, from 18 months to six months for most new products. However, this standardization also makes product differentiation more difficult. Using standard silicon, for instance, many products will have similar features and performance. This means users will make purchase decisions based on brand loyalty and experience with a retailer—making customer support more important than ever.

Cost and quality of devices will decrease

As memory and silicon costs decrease due to production efficiency, and as companies continue to relocate design and production facilities to lower-cost sites, both the street price and quality of consumer electronic devices will continue to decline. While the decrease in cost will make these devices more attractive to consumers, the sacrifice in quality may affect the user experience. This means that after-sale support will become much more important than before, and there will be a trend toward disposable electronics.

PRODUCT TRENDS

As mentioned in the previous section, products are becoming more compact and more portable. The lower cost and better integration of embedded silicon and flash memory will enable manufacturers to develop small, feature-rich products that appeal to consumers. Following is a sample of such products that are new to the market:



DiskGO!™ by Peripheral Enhancements Corp. is a USB watch flash drive that comes with 128 Mb or 256 Mb and a USB 1.1 interface (not USB OTG yet). Security software provides password protection. Additional information about this product is available at <http://www.edgememory.com/products/edm/New%20Products.asp>.

NTT DoCoMo offers WRISTOMO, a wristwatch-style cell phone with web capability. (Some models of this wristwatch also play movies.) The product provides 120 minutes of continuous talk time. Although the data rate is not high—up to 64Kbps—the watch is very convenient and fashionable. Currently this product is only sold in Japan; however, it is certainly a sign of things to come and a good candidate of USB OTG. Additional information about this product is available at <http://www.wristomo.com>.



Microsoft has teamed up with watchmakers to introduce Smart Watch using the company's Smart Personal Objects Technology (SPOT). Microsoft will provide information, like stock quotes, weather, and traffic, over an FM radio to the watch. This product will be available by Christmas 2003.

Creative Labs currently ships many models of personal entertainment devices such as the Nomad series MP3/flash memory/digital recorder combo unit. In the future, handheld modular devices that allow users to select one or more of the functions to be included will be available. Additional information about this product is available at www.creativeabs.com

iRiver packs all these functions into a single device: MP3, 512 MB flash memory, FM tuner, voice and FM recorder. Weighing only 32 grams, this wearable device uses USB as its connection. However, USB OTG will most likely be used for future products in this category. Additional information about this device is available at <http://www.iriveramerica.com/products/iFP-195T.asp>.



USB OTG MARKET FORECAST

For the purposes of this report, USB OTG products have been divided into the following categories:

- PCs
- PDAs
- Personal Entertainment Devices
- Cellular Phones
- Digital Cameras
- Digital Camcorders
- MP3 Players
- Photo Printers
- Silicon
- Cables and Connectors

For each product group, a description of the products within the group is provided in this section, as well as the projected unit shipments of products over five years. As discussed earlier, this data has been obtained using both primary and secondary research. While the projection of sales has been created based on a set of reliable input, two key assumptions have been made:

- Economy will recover in two years, as predicted. The projection of shipments of USB OTG products has been calculated based on the economic forecasts of a slow economy worldwide with faster growth in Asian markets, like China and India. A slower than predicted economic recovery will affect these forecasts.
- USB OTG members will sustain their enthusiasm. The forecast assumes that the 30-member group will sustain their current level of enthusiasm and participation. These companies include manufacturers of IP, silicon, cell phones and PDAs. If these members lose interest in USB OTG, the actual shipments could be greatly impacted.

The spreadsheet containing all the projected shipments is provided in Appendix A.

Personal Computers

The growth rate of PC systems worldwide has slowed since 2001 and is expected to recover slowly. The overall growth rate during 2003 has been about 5.5%, and is expected to increase to 7% in 2004/2005. Mobile PCs, on the other hand, which account for about 23% of the overall PC sales, are expected to have a growth rate of 20% or more—much higher than that of the desktops.

The U.S. consumes about 35% of the world's PC, while Asia Pacific consumes 16%. This distribution is expected to shift slowly with Asia increasing to 20% during the next five years. It is important to note that China accounts for about 40% of overall Asian sales, followed by Korea with 13%, Australia with 10%, India with 10%, and Taiwan with 10%. These percentages are expected to remain the same, except for India's, which is expected to increase over the next few years.

These figures include the tablet PC, a relatively new product on the market. Though it provides some benefits such as handwriting recognition and screen design with flexible movement, the tablet PC has not gained much momentum, accounting for about 1% of overall PC sales.

It is important to note that 100% of these machines have at least one USB port installed, with most of the new desktop PCs containing an Intel motherboard with six USB 2.0 ports installed.

Following is the forecast for shipments of USB PCs over the next five years. These figures represent PCs with USB 2.0 ports, which are compatible with USB OTG ports.

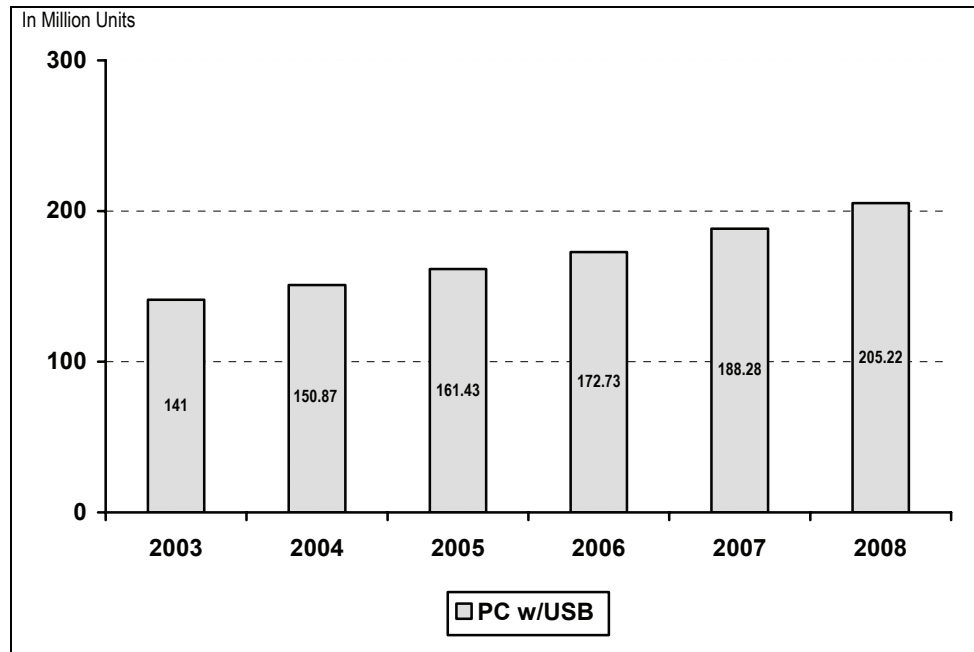
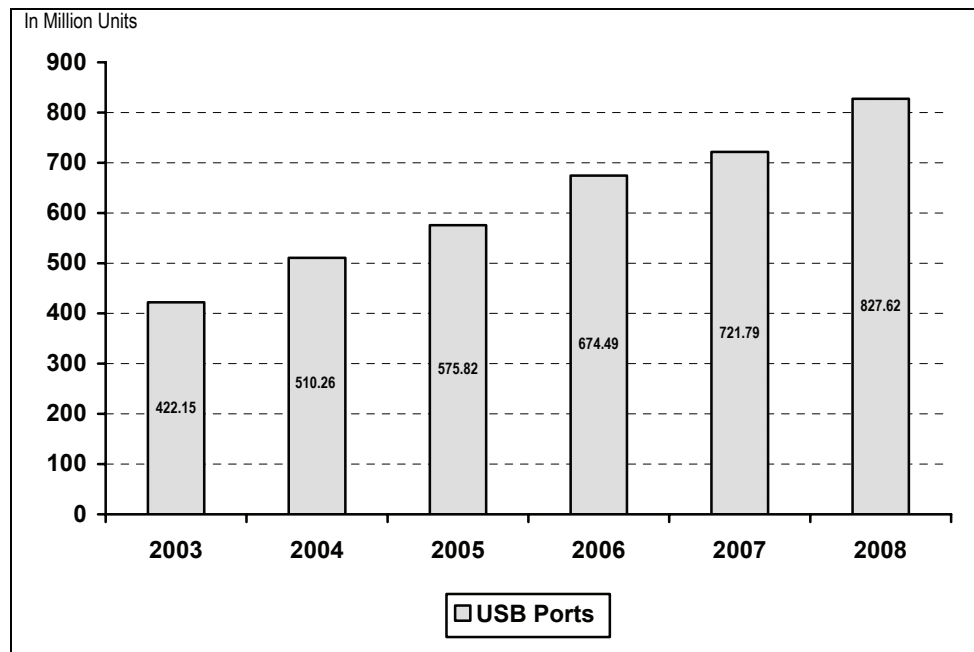


FIGURE 3. PROJECTED SHIPMENTS OF USB PCs

Following is the forecast for installation of USB ports on desktop and laptop PCS over the next five years. These figures represent PCs with USB 2.0 ports, which are compatible with USB OTG ports.



As shown, the rate of increase in the number of USB ports installed on PC systems will peak, and then begin to decline in 2007. This is because the number of ports on desktop PCs will increase initially (from two to six); however, desktop PCs will give way to notebook computers, which have only one or two ports. The latter will steal market share from desktop PCs, resulting in a slow down of the rate increase in USB ports.

PDA's

Personal Digital Assistants (PDAs) have become popular over the last few years since Palm Pilot was introduced many years ago, and since the introduction of pocket PCs (like HP's iPAQ) that use the Microsoft CE operating system, and the Linux PDAs.

Even though Palm's market share has been lost to the many competitors appearing in this market space, the company has maintained a 35% market share, with HP owning about half of that. Two newcomers to this market, Sony and Dell, own about 16% and 6% (respectively) of the market. It is important to note that Sony has gained significant share in the last two years.

The growth of PDA devices continues to be moderate, with new applications being added. Such applications include voice input/phone capability, and the potential use of the PDA as a back-up device.

The PDA's primary interface requirements are the ability to synchronize with a host PC, and to exchange information with other devices including cell phones, cameras, and camcorders. To sync with a host PC, these devices currently rely on a proprietary cradle that provides a serial or USB connection to the host PC. For exchanging information with other devices, PDAs use a built-in infrared interface. The use of these interfaces is not expected to change for about two years.

USB OTG will be an ideal replacement for the existing cradle design. The USB OTG connector is much smaller, and will be able to replace the proprietary design of the PDA connector. (Sony has already announced its intention to use USB OTG for its Clié model.)

Replacement of the infrared interface depends on the evolution of this technology in other applications. For instance, if infrared can be used as a form of payment, the PDA potentially can be used as a digital credit card. In this case, infrared will continue to be part of PDA for a long time. Other wireless technologies such as Bluetooth and 802.11x may have an impact on infrared.

Following is the forecast for shipments of USB OTG PDAs over the next five years.

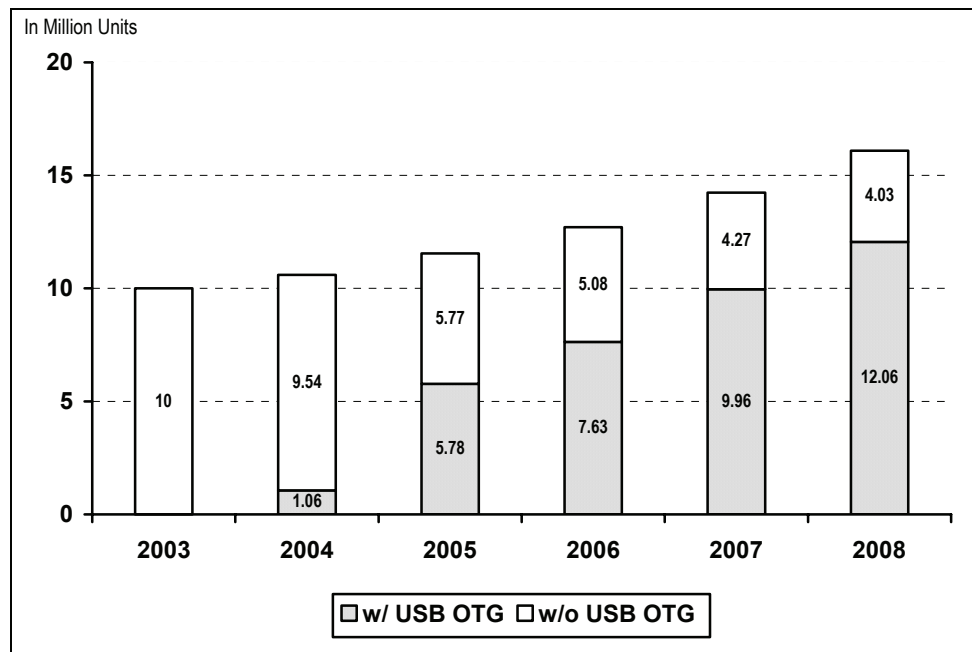


FIGURE 4. PROJECTED SHIPMENTS OF USB OTG PDAs

Personal Entertainment Devices

Personal Entertainment Devices (PED), a new category of consumer electronic devices, comprises the multimedia devices that provide multiple functions including MP3 music, photography, video record/playback, and the like. More and more functions are being integrated in these compact handheld units, including:

- Email
- Music such as MP3
- Camera
- Camcorder
- Wireless communication
- Watch
- Backup function such as the USB flash memory or disc drive
- Digital recording
- Games

As PED gain in popularity, these devices will be designed as fashion accessories of different colors and appearances to appeal to all types of consumers.

The average life span for a PED is about 18 months as consumers replace these devices with newer more function-rich devices, rather than waiting for the device to stop working. As a result, the product life of these devices can be shorter, enabling manufacturers to take advantage of more cost-efficient components.

Following is the forecast for shipments of USB OTG PEDs over the next five years.

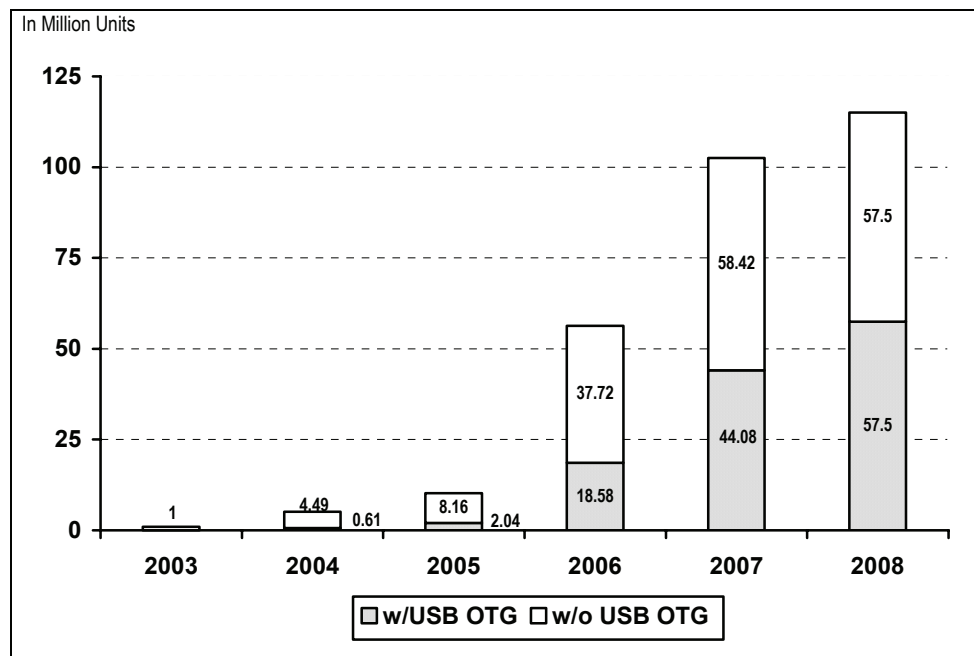


FIGURE 5. PROJECTED SHIPMENTS OF PERSONAL ENTERTAINMENT DEVICES

As shown, most of the growth in PEDs will occur between in 2005 and 2007. This is partly due to the newness of the product, and partly due to the demand from Asian countries such as China and India. The growth will begin to level off in 2008.

Cellular Phones

Cellular phones remain to be the fastest growing consumer electronic segment in the world with most of the demand coming from Asia. China's cellular phone sales have exceeded that of the U.S., mainly due to the lack of landline infrastructure. In that country, wireless cells are actually easier to install than a cable system.

The current worldwide leader in cell phone handsets is Nokia with 35% market share, followed by Motorola (15%), Samsung (11%), and Siemens (7%). This may change as China's mobile phone market heats up since it is

very easy for local brands to establish themselves in that marketplace. This occurred with the Legend PC brand, which leads PC sales in China today.

Currently the main application for cellular phones is voice communication. However, with the introduction of Microsoft Window CE .net-based smart phones, some of the PDA data capability will be incorporated into cellular phones. This includes applications such as contacts, word processing, spreadsheets, games, cameras, digital recording for short messages, and MP3.

The cellular phone is the one device that most people are willing to carry almost all the time. However, due to its requirements for a lightweight, compact size, these devices offer a smaller display and fewer functions than that of new PED devices. That means that cellular phones will be compact with fewer features, while the new PED will be feature-rich with added weight and size.

Current cellular phones have a proprietary cable connection for data and/or power. USB OTG will replace the proprietary connector, thus reducing the costs and making it easier to interface with other USB OTG devices.

Following is the forecast for shipments of USB OTG cellular phones over the next five years.

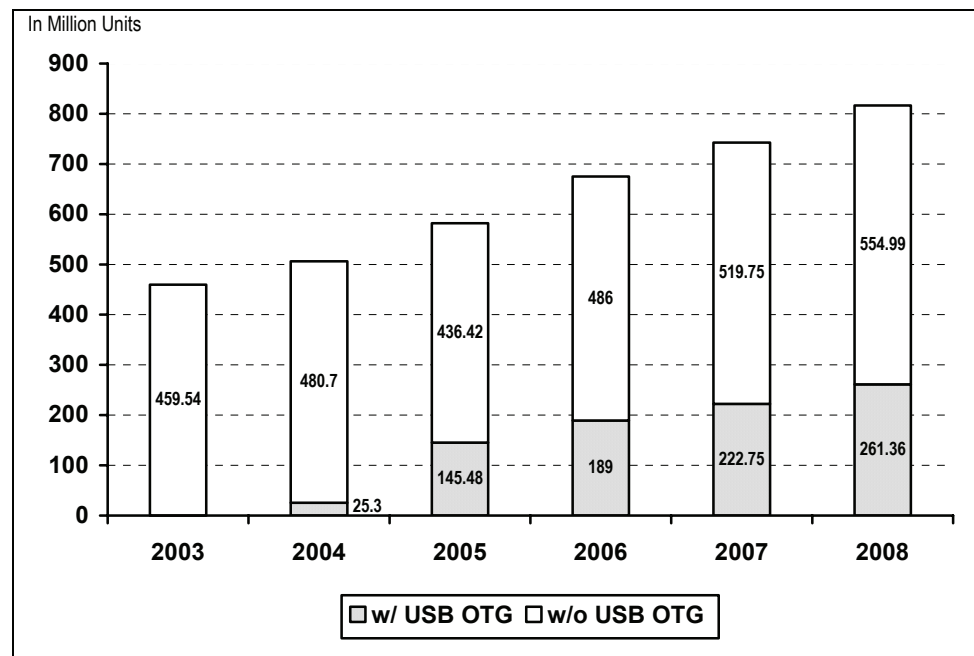


FIGURE 6. PROJECTED SHIPMENTS OF USB OTG CELLULAR PHONES

As shown, it is expected that in five years USB OTG cellular phones will account for 32% of all the cellular phones shipped. Among others, Qualcomm, a major proponent of USB OTG, will incorporate USB OTG technology in its

CDMA silicon. Cellular phones will continue to use other interfaces, such as infrared, which is being used in Asia as a digital payment method promoted by VISA. MasterCard also uses cell phones for payments using a radio frequency method.

Digital Cameras

In two years, the cost of most digital cameras will decrease with mid-range cameras costing around \$150 and basic versions that include flash and zoom functions costing less than \$100. The major growth in digital cameras will come from the low-cost camera. The growth of high-end cameras with prices of \$500 or more will be limited to more sophisticated users, so the volume will remain relatively low.

Flash memory, one of the technologies that has greatly benefited from the growth of digital cameras, will continue to be used to store images for the foreseeable future. USB OTG is expected to be included in digital cameras, as its small footprint is well suited in a small camera.

It is interesting to note that the top digital camera brands are from Japanese manufacturers, including Canon, Fuji, Olympus, and Sony. Due to the shift in technology, from film to digital, the leading companies have shifted. Traditionally an electronics company, Sony is a leader in digital cameras. On the other hand, Polaroid, once a leader in the commercial camera market is not a leading player in the digital camera market today. Following is the forecast for shipments of USB OTG digital cameras over the next five years.

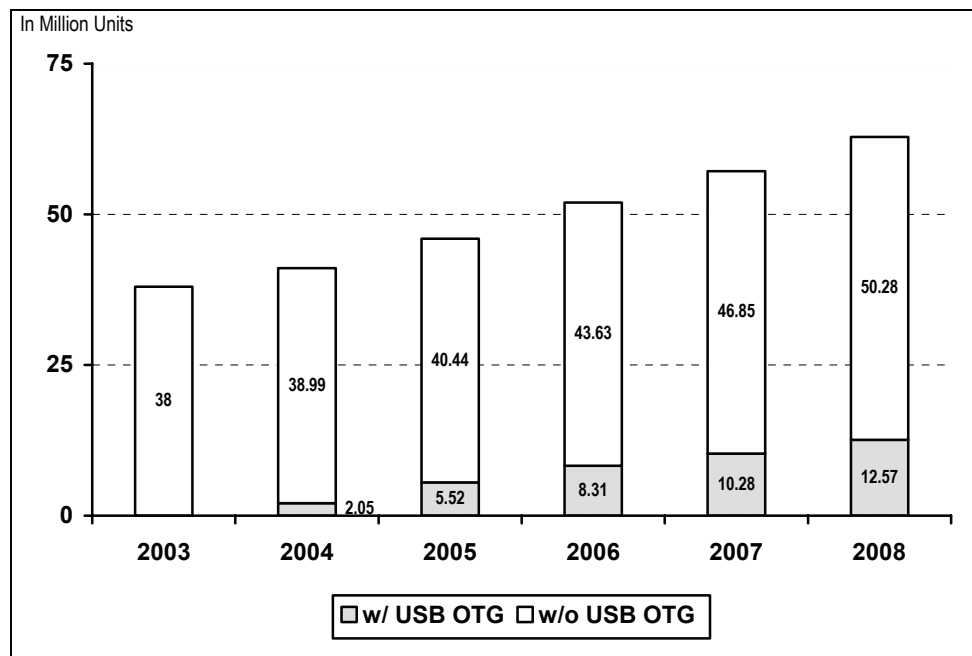


FIGURE 7. PROJECTED SHIPMENTS OF USB OTG DIGITAL CAMERAS

Digital Camcorders

IEEE 1394 is expected to be the interface of choice in the next few years for digital camcorders. While USB OTG is a good candidate for the digital camcorder interface, high-speed USB (480 Mbps) must be designed in order for it to be useful. Therefore, it is very possible that digital camcorders will continue to use a USB 2.0 connection rather than USB OTG.

Following is the forecast for shipments of USB OTG digital camcorders over the next five years.

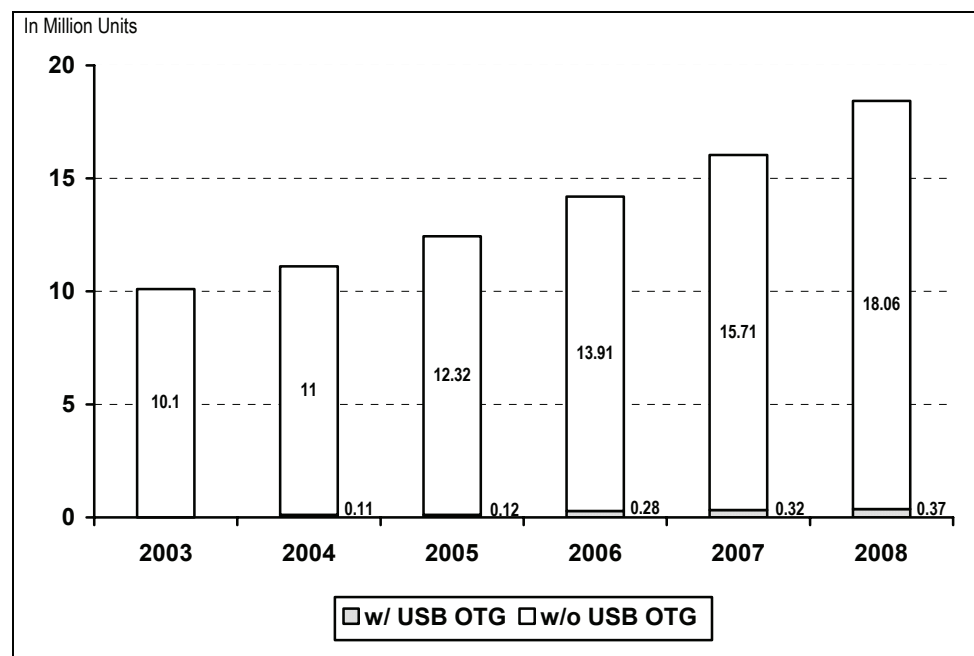


FIGURE 8. PROJECTED SHIPMENTS OF USB OTG DIGITAL CAMCORDERS

MP3 Players

Digital audio is a growing market segment, which is expected to expand to almost 13 million units by 2008. Although most of this market includes CD players, approximately 20% of the market will be MP3 players.

The current volume of MP3 players today is not very high. However, as the cost of memory continues to decline, and as the music industry continues to work out the details of on-line sales of music, MP3 is expected to experience a rapid growth.

The five-year forecast below includes MP3-only devices. However, it is important to note that the MP3 function is often included in other devices, such as smart phones or personal entertainment devices.

Following is the forecast for shipments of USB OTG MP3 players over the next five years.

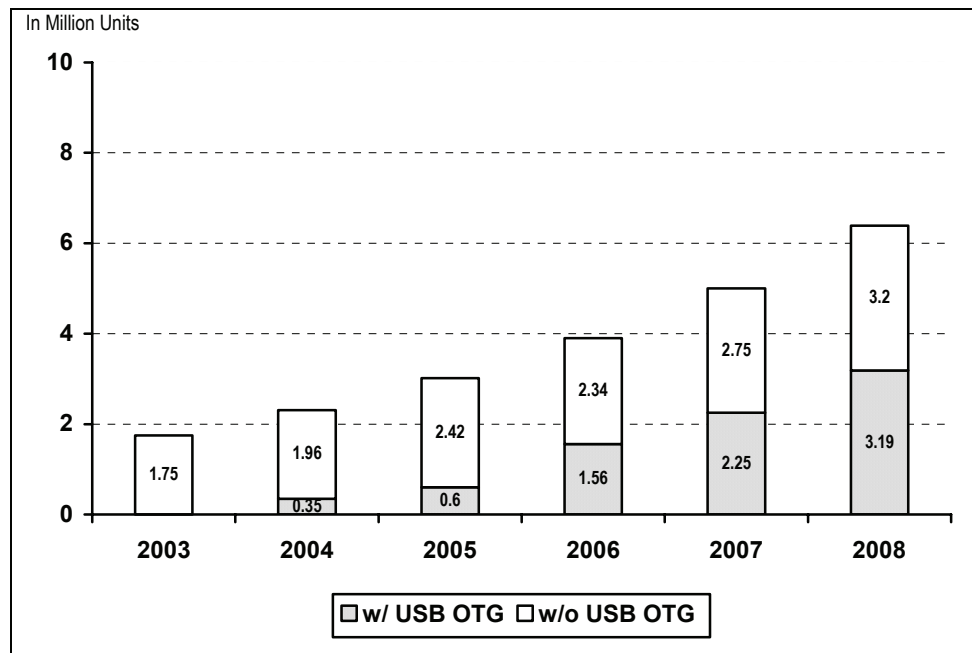


FIGURE 9. PROJECTED SHIPMENTS OF USB OTG MP3 PLAYERS

Photo Printers

One of the key benefits of USB OTG photo printers is the convenience of printing directly to the printer from a USB OTG digital camera. After viewing the photos on the digital camera display, the user will be able to print the selected photos from the camera, without interfacing through a PC. Due to the growth of the digital photography market, this is an ideal application for USB OTG.

Following is the forecast for shipments of USB OTG printers over the next five years.

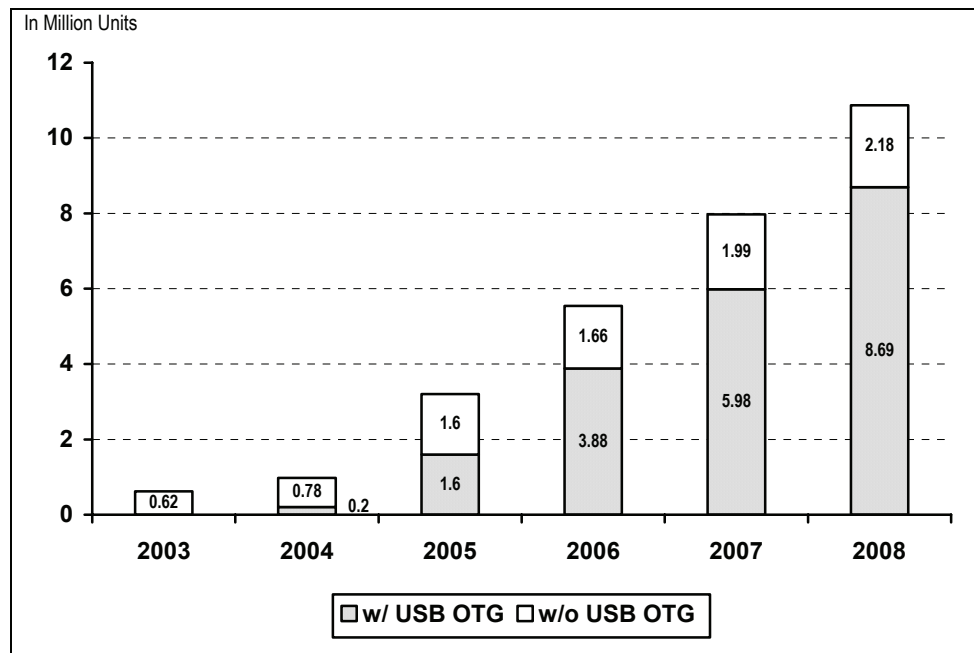


FIGURE 10. PROJECTED SHIPMENTS OF USB OTG PRINTERS

As shown, the initial growth of USB OTG printers will be slow due to the cost printers. However, it is expected that within two years USB OTG photo printers will become more affordable (with street prices of less than \$100), more compact, and more efficient. Eventually USB OTG printers will account for about 80% of the photo printers shipped.

Silicon

The total shipments of USB OTG silicon will grow tenfold over a five-year period—from 30 million units in 2004 to roughly 370 million units by the end of 2008. Sales of USB OTG cellular phones, PDAs, and PED devices will drive the silicon market.

Due to the anticipated volume, it is expected that the cost of the silicon will decrease from less than \$6 per connection to less than \$1 within a few years.

Following is the forecast for shipments of USB OTG silicon over the next five years.

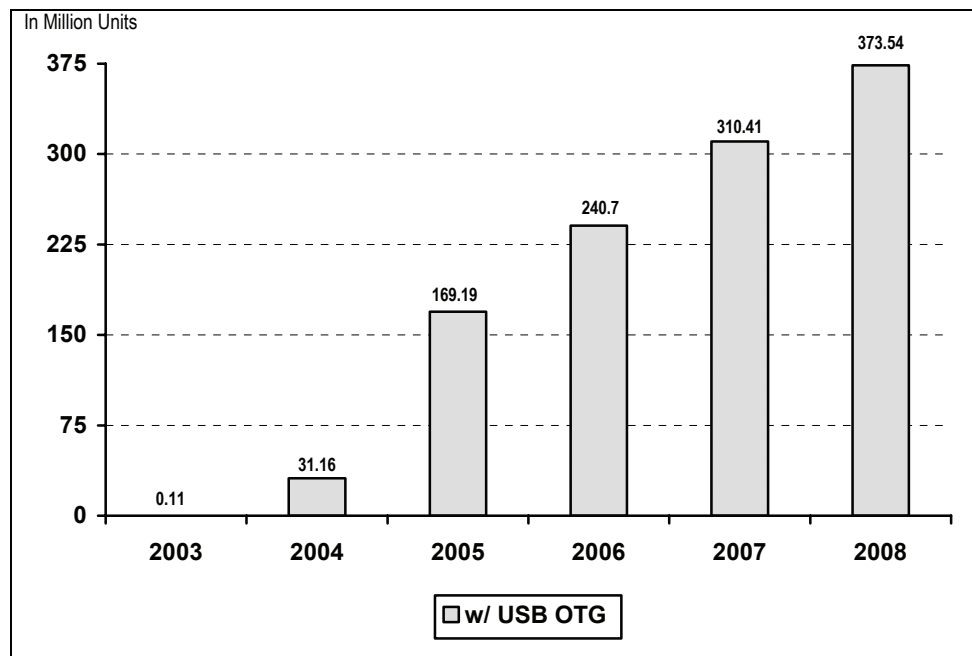


FIGURE 11. PROJECTED SHIPMENTS OF USB OTG SILICON

Cables and Connectors

The forecasted volume for USB OTG cables and connectors is quite high, reaching a combined total of over one billion in 2008. USB OTG cables and connectors are expected to eventually experience the price erosion that occurred within the USB cable and connector market.

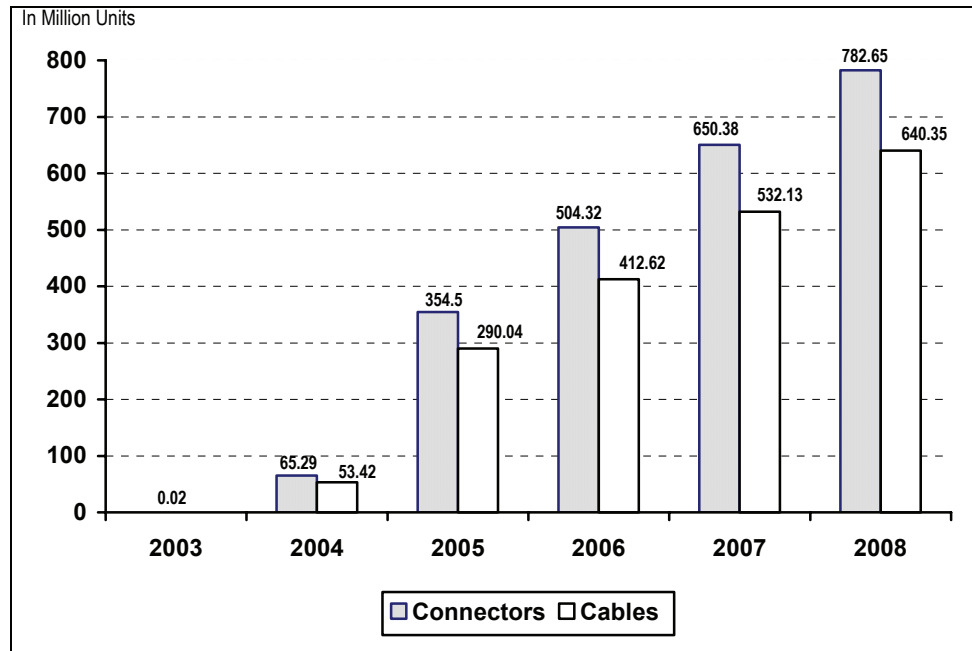


FIGURE 12. PROJECTED SHIPMENTS OF USB OTG CABLES AND CONNECTORS

APPENDIX A: FIVE-YEAR FORECAST SPREADSHEET

Following is the five-year forecast spreadsheet that was used to create the graphs in the previous section.

In Million Units	2003	2004	2005	2006	2007	2008
PC SYSTEMS						
PC Systems (100% USB)	141.00	150.87	161.43	172.73	188.28	205.22
USB Ports Installed (desktop and laptop PCs)	422.15	510.26	575.82	674.49	721.79	827.62
PDA						
Total PDAs (including Palm, CE and others)	10.00	10.60	11.55	12.71	14.23	16.09
PDAs with USB OTG	0.00	1.06	5.78	7.63	9.96	12.06
Personal Entertainment Devices						
Total PEDs (including compact handheld and watches)	1.00	5.10	10.20	56.30	102.50	115.00
PEDs with USB OTG	0.00	0.61	2.04	18.58	44.08	57.50
CELLULAR PHONES						
Total Cellular Phones	460.00	506.00	581.90	675.00	742.50	816.75
Cellular Phones with built-in or add-on camera	4.60	50.60	81.47	114.75	141.08	163.35
Cellular Phones with USB OTG	0.00	25.30	145.48	189.00	222.75	261.36
DIGITAL CAMERAS						
Total Digital Cameras	38.00	41.04	45.96	51.94	57.13	62.85
Digital Cameras with USB OTG	0.00	2.05	5.52	8.31	10.28	12.57
DIGITAL CAMCORDERS						
Total Digital Camcorders	10.10	11.11	12.44	14.19	16.03	18.43
Digital Camcorders with USB OTG	0.00	0.11	0.12	0.28	0.32	0.37

USB OTG TECHNOLOGY AND MARKET REPORT

In Million Units	2003	2004	2005	2006	2007	2008
DIGITAL AUDIO/MP3 Players						
Total Digital Audio	7.00	7.70	8.62	9.75	11.11	12.78
Total MP3 Players	1.75	2.31	3.02	3.90	5.00	6.39
MP3 Players with USB OTG	0.00	0.35	0.60	1.56	2.25	3.19
PHOTO PRINTERS						
Total Printers (excluding photo printers)	31.00	32.55	34.50	36.92	39.87	43.46
Total Photo Printers	0.62	0.98	3.20	5.54	7.97	10.87
Photo Printers with USB OTG	0.00	0.20	1.60	3.88	5.98	8.69
SILICON						
USB OTG Silicon	0.11	31.16	169.19	240.70	310.41	373.54
CONNECTORS AND CABLES						
USB OTG Connectors	0.02	65.29	354.50	504.32	650.38	782.65
USB OTG Cables	0.02	53.42	290.04	412.62	532.13	640.35