Windows Platform Design Notes

Design Information for the Microsoft® Windows® Family of Operating Systems

Recommendations for Booting Windows from USB Storage Devices

Abstract

This paper provides information about booting the Microsoft® Windows® family of operating systems from Universal Serial Bus (USB) storage devices. It provides guidelines for BIOS vendors, IHVs, and OEMs to work together to create USB boot enabled products.

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Introduction

The USB Mass Storage Working Group is preparing a specification on booting USB devices to enable booting from USB within the industry. Boot from USB has become a highly requested feature. Both USB flash drive (UFD) and USB CD-ROM drives are in a position to pave the way of new booting features on USB. Enabling users to boot from UFD and USB CD-ROM requires industry-wide cooperation to ensure good user experiences with these devices.

The most interesting applications for booting from a USB device focus on operating system deployment, system recovery, and system maintenance. Key scenarios, listed below, are explored later in this document:

- Operating system installation/deployment scenario
- Floppy disk drive replacement
- System diagnostics tools
- Disk duplication/manipulation (for example, partitioning and formatting utilities)

Current versions of Windows should not be installed to USB hard disk drives because Windows does not support USB hard disk drives as the primary boot device. This paper introduces the expected industry participation related to the following:

- Key scenarios for booting off a USB storage device
- Windows requirements on boot devices.
- Requirements and recommendations for various industry partners
- BIOS manufactures
- System builders for home/business PCs.
- UFD manufacturers (IHVs)

The information in this paper is intended for x86 BIOS vendors, IHVs, and OEMs to encourage cooperation in creating USB-boot-enabled products for the Microsoft® Windows® family of operating systems

Scenarios for Booting from USB Storage Devices

USB Flash Drives

To date, Microsoft has received many requests for boot support for the USB flash drive (UFD). Many OEMs and IHVs have designated UFDs as the next replacement for floppy disk drives, but some in the industry are not ready to declare UFDs a true floppy disk drive replacements until the drives can boot an operating system like floppy disk drives today. Given the faster data transfers, higher capacities, and other technological gains of UFDs, many in the industry believe that the ability to boot to an operating system would truly allow the industry to move from floppy disk drives to UFDs.

The capacities of UFDs are growing rapidly. Within a few years, they will surpass the storage capabilities of CD-ROMs as the price per MB continues to decline. UFDs can be used like fast, light, removable hard drives, and the user scenarios that are the most interesting, beyond floppy disk drive alternatives, come from the

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possibility of creating alternative methods of booting a computer for deployment and recovery purposes.

Plugging in a UFD to add another bootable disk allows for easy operating system deployment, recovery, and the ability to run disk manipulation utilities that cannot or should not be run from the disk or partitions they are manipulating. Some of the compelling scenarios to boot off UFD are explained in detail below.

- **Operating system installation/deployment scenario** – Mobile platforms or low-profile desktop systems may ship without embedded floppy disk drives. Having a bootable UFD with an OEM pre-installation environment dramatically simplifies the task of OS installation. This is a valuable scenario for the OEM and for corporate IT administrators or the home consumer seeking to deploy or redeploy an operating system.
- **System diagnostic tools** – IT managers may need to run system utilities on a machine without starting the operating system, or to recover a system with a non-starting operating system. For systems that do not have a bootable floppy/CDROM and lack Preboot eXecution Environment (PXE) bootability, booting off UFDs is both compelling and simple. IT managers can also carry their system diagnostic tools on a 512 MB UFD and perform their tests easily. This is a valuable scenario for corporate consumers or the home consumer seeking to recover data from a non-bootable system.
- **Disk duplication/manipulation/verification** – Disk partitioning and formatting utilities need to run before operating system startup or from another operating system. It is possible to boot off a UFD that also contains partitioning utilities or other diagnostic utilities. It is also possible to include a virus checker on a read-only UFD for disk verification purposes. This is a valuable scenario for the OEM and for corporate consumers or the home consumer seeking to configure or reinstall the operating system for deployment or recovery.

CD-ROM Drives

USB is an acceptable storage bus for CD-ROM drives. Currently, many USB CD-ROM drives are targeted as external attachments for laptops that are valuable because of their small form factors. In the future, CD-ROM drives may take advantage of USB inside the case to create constant connections much like AT Attachment (ATA) is used today or as Serial ATA (SATA) may be used in the future.

The natural scenario for booting from a USB CD-ROM drive will still be for initiating operating system setup. Operating system recovery would also be an expected use, for instance for the Windows Recovery Console used from a USB CD-ROM drive.

Windows Requirements for Boot Devices

The best thing about adding another bootable bus to Windows is that manufacturers can take advantage of much of the existing Windows boot process. As long as a new device looks and behaves like existing devices while NT Loader loads the system, new devices can be made to work like old devices. The goal for booting Windows from a USB device is to use as much of the existing Windows boot process with as little change as possible.

This paper focuses solely on booting from hard disk drives and CD-ROM drives for recovery and deployment purposes. Windows as it exists today is currently not optimized to run as an installed operating system from USB attached mass-storage or CD.

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The USB Mass Storage support consists of storage protocols over USB that enable USB hard disk drives and USB CD-ROM drives. All storage devices that are to be boot devices for Windows should behave like one of those two categories to take advantage of the existing boot process. DVD-ROM drives fit into the category of CD-ROM drives for the purpose of this document.

BIOS must support INT 13h During the boot process, Windows assumes that support for communicating with the boot device, either hard disk drive or CD-ROM drive, is present in INT 13h when Windows loads because the NT Loader uses calls to INT 13h to access the disk. INT 13h support must comply with the "BIOS Enhanced Disk Drive Services – 2" specification and the "USB Mass Storage Specification for Bootability," The newer specification is considered the authority if the two specifications contradict each other.

Accurate drive numbering by BIOS Windows also requires that the assignment of drive numbers follows "Compaq Phoenix Intel BIOS Boot Specification version 1.01." Hard disk drives should begin numbering at 80h and CD-ROM drives should begin numbering at 82h, as in the past.

In this paper, the remainder of the requirements, along with recommendations for component manufacturers, has been organized by the different components that play a part in booting.

Requirements and Recommendations for BIOS Manufacturers

It should be no surprise that the Windows boot requirements on BIOSes for current buses extends to USB. BIOS support for USB hard drives and USB CD-ROM must comply with the "Compaq Phoenix Intel BIOS Boot Specification version 1.01" as hard drives and CD-ROM drives on other buses do today.

New requirements come from the USB Mass Storage Working Group which is currently working on a specification to standardize booting from USB storage devices called the "USB Mass Storage Specification for Bootability". At the time of this writing, this specification is currently at revision 0.8. Additionally, when it is published it will have an appendix that illustrates INT 13h support and should be followed.

Additionally the USB Mass Storage Working Group has constricted the Control/Bulk/Interrupt (CBI) Transport to only apply to floppy disk drives. BIOSes should simplify their designs by supporting only the Bulk-Only Transport (BOT) as CBI can not be used for hard drives and CDs.

An interesting task around BIOS support for booting from USB is the realm of user experience. The goal for adding BIOS support for booting from USB should be to maintain an end user experience that is the same as today's experience. It is tempting to make USB boot devices separate from devices supported today, but keep in mind users boot from devices and not from busses.

The recommendations about displaying boot device options made in section 1.4 of the "El Torito Bootable CD-ROM Format Specification" Version 1.0, which USB BIOS support for bootable CDs must comply with, still holds true. The option to boot from a USB CD-ROM should not be separate from booting from a CD-ROM on another bus. Likewise hard drives should be grouped together so that the option to boot from a USB hard drive is not separate from booting from a hard drive on another bus.

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Although other busses can be used for booting, the consideration of adding boot support on USB is unique because USB is commonly implemented in chipsets making it the second bootable bus on a chipset. BIOS manufacturers have a great opportunity to leverage their work in the BIOS to extend the methods used to boot from ATA controllers to USB controllers. Like ATA, the BIOS should support booting from all USB ports on the chipset.

ATA connectors are designed to only be within the case, and USB connectors are often considered to be external, but they are not limited to external only. Although USB CD-ROM drives are generally external devices today, USB CD-ROM drive may be used as the primary CD-ROM drive in a system that does not have an ATA connection for a CD-ROM drive.

Recommendations for Motherboard Manufacturers and OEMs

Recommendations for motherboard implementations focus on placing USB connectors on a motherboard.

USB has the potential to be useful for some types of common storage devices like CD-ROM drives. Motherboard manufacturers, like BIOS manufacturers, should plan to design motherboards that have internal USB connectors for storage.

BIOS support for booting from USB storage devices is only required to enumerate devices that are at least 2 hubs deep. This should be a consideration when using USB hubs on the motherboard to create more ports. Users will not be aware of the hub on motherboard and USB devices that do not boot because of unseen hubs may cause users confusion.

Finally, external USB connectors that can be used to boot should be placed in an easy to reach location such as on the front fascia of a desktop or server computer system, or on the left or right side of a laptop. It should as easy for a user to access as CD-ROM drives and floppy disk drives are today.

Requirements and Recommendations for USB Storage Devices

The USB Mass Storage Working Group is also looking into in the near future at a specialized USB logo for storage. Manufacturers are strongly encouraged to ensure that all storage devices comply with these tests when they are ready. However, it should be noted that passing all USB Storage logo requirements will not guarantee that a device will qualify to receive a “Designed for Windows” logo.

Additionally the USB Mass Storage Working Group has limited the application of Control/Bulk/Interrupt (CBI) Transport to floppy disk drives only. It is recommended that no new USB devices using the CBI Transport be implemented. BOT should be used instead.

Hard disk drives shouldn’t report themselves as removable media drives because Windows will not put a page file on a removable media device. The only storage devices that should report themselves as removable media devices are those devices that are capable of ejecting media while the drive stays connected to the system. USB hard disk drives and UFD drives should report themselves as fixed disk drives or removable disk drives.

Finally, for speed benefits, it is recommended that USB devices support USB 2.0.

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Windows Logo Program Issues

New USB storage devices that only support Control/Bulk/Interrupt Transport will not be given logos.

BIOSes that support booting from USB storage devices shall enumerate devices at least 2 hubs deep.

Call to Action and Resources

Call to Action:

For BIOS manufacturers:

- Make booting USB devices transparent to the user
  - No additional key sequences
  - Same user experience as booting from any other bus
- Support booting as defined in the following specs
  - "BIOS Enhanced Disk Drive Services – 2"
  - "USB Mass Storage Specification for Bootability"
  - "El Torito Bootable CD-ROM Format Specification"
  - "Compaq Phoenix Intel BIOS Boot Specification"
- Support BOT
- All USB ports should be bootable

For motherboard manufacturers:

- Prepare for when USB may be used as a static bootable storage connector within the case.
- Place at least one USB port on the front of Desktop PCs.
- Place at least one USB port on the left or right side of mobile PCs.

For USB storage device manufacturers:

- Secure USB Mass Storage logos when they become available
- Don't use Control/Bulk/Interrupt Transport
- CD-ROM drives should identify themselves as removable media devices; hard disk drives should identify themselves as fixed drives or removable drives.
- USB storage devices should be Hi-Speed USB 2.0.

For more information about booting from USB storage devices…

- Questions about booting from USB storage devices can be sent to usbstor@microsoft.com
- Questions specific to UFDs (that is, operating system support) can be sent to ufdboot@microsoft.com

Resources:

"BIOS Enhanced Disk Drive Services – 2"
http://www.incits.org

"USB Mass Storage Specification for Bootability "
http://www.usb.org/home

"El Torito Bootable CD-ROM Format Specification"
http://www.phoenix.com/resources/specs-cdrom.pdf

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"Compaq Phoenix Intel BIOS Boot Specification"
http://www.phoenix.com/resources/specs-bbs101.pdf

Designed for Microsoft Windows XP Application Specification
http://www.microsoft.com/winlogo/software/windowsxp-sw.mspx

Microsoft Hardware and Driver Developer Information
http://www.microsoft.com/hwdev/

Microsoft Platform Software Development Kit (SDK)
http://msdn.microsoft.com/downloads/

Microsoft Windows Driver Development Kit (DDK)
http://www.microsoft.com/ddk/

Microsoft Windows Logo Program System and Device Requirements, version 2.1a
http://www.microsoft.com/winlogo/hardware/

Windows XP Application Compatibility Toolkit
http://msdn.microsoft.com/compatibility/

Microsoft Windows XP Hardware Compatibility Test Kit, version 11.2
http://www.microsoft.com/hwtest/

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