Core Improvements in Windows® Embedded CE 6.0 R2

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Summary: Windows Embedded CE 6.0 R2 contains a number of improvements to the core set of drivers and operating system components. This paper describes those improvements and how they impact the operating system

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Introduction

Microsoft has recently re-released Windows Embedded CE 6.0 with a handful of new drivers, upgraded configurations and additional features. This release, dubbed Windows Embedded CE 6.0 R2, provides some welcome improvements to the CE package. While this release has improvements in a number of areas, this white paper will focus on the improvements in the operating system, driver, and board support package areas. These improvements will benefit all OEMs regardless of the target focus of their devices.

Before diving into the upgrades of specific drivers and other components, a mention needs to be made of an upgrade that affects the entire operating system. Since the release of Windows Embedded CE 6.0, monthly QFEs, (Quick Fix Engineering) updates have been released by Microsoft that fix bugs that have been found in the code. This new release of Windows Embedded CE incorporates all the QFEs that have been released over the last year. So, a one-time install of the CE 6.0 R2 code brings with it all the fixes that have been released for Windows Embedded CE 6.0. This single install is just a bit easier than installing 10 separate monthly QFEs each specific to a CPU type. Now that the QFE issue has been solved, let's look at a few of the other improvements in R2.

New Drivers

Drivers are the life blood of a Windows Embedded CE system and so nothing is more welcome to a Windows Embedded CE OEM than a set of new and improved device drivers. Without drivers, OEMs have to rededicate scarce engineering talent to write drivers and not to implementing the features that their customers want. While Microsoft has done a great job of providing example device drivers in Platform Builder, new drivers are always a good thing.

Serial ATA Disk Driver

The first driver to be discussed is a simple but welcome update to the ATA hard disk driver. The hard disk driver has been upgraded to support serial ATA controllers. The previous driver only supported the older parallel ATA disk controllers which are becoming a bit rare as the personal computer manufactures move to the newer serial ATA technology.

The driver was written to the Promise PDC40518 SATA card, but as is usual with these types of drivers, the set of commands used by the driver should be compatible with other SATA cards available on the market. Since the new SATA support is integrated into the existing driver, developers don't have to do anything but build the operating system to gain the new hardware support.

A walk through the updated driver code will show that in addition to the SATA support, the driver has had some general tuning and improvements. For example, the driver is now more configurable through the registry with the ability to specify a PCI vendor and product ID as well as a custom driver constructor.

For those interested in the adaptations for the 40518, the new files pdc40518.cpp, pdc40518.h, and pdc40518.reg have been added to the driver code in public\common\oak\drivers\block\atapi.

Secure Digital 2.0 Host Controller Driver

Another driver that has been updated is the Secure Digital host controller driver. The SD controller driver has been updated to support hardware the implements the SD 2.0 specification. Secure Digital 2.0 provides faster I/O speeds for SDIO cards up to a 50 MHz clock rate and read/write speeds up to 25 MB/second in 4 bit mode. This new specification also supports a block addressing mode with fixed block lengths of 512 bytes for supported cards.

In addition to faster speeds for SDIO Cards, SD 2.0 also supports high capacity memory cards up to 32 gigabytes. The earlier SD 1.1 driver limited memory cards to a 4 GB size. As these high density cards are coming on the market, the older SD 1.1 limit has become somewhat of an issue.

A new USB smartcard reader driver has been added in R2. While Windows Embedded CE has supported a specific smart card reader previously, the driver works with USB card readers that support the Chip/Smart Card Interface Devices Specification. A number of smart card readers support this specification so this allows OEMs choices on card readers that previously didn't exist.

New Flash Driver

The flash driver has also been updated. It now supports newer flash technology as well as being re-architected to better conform to the standard Windows Embedded CE driver model. The new flash driver supports multi-layer cell support, where each flash cell stores more than one bit per cell. While multi-layer cell support is popular on new, high density flash devices, it requires changes in the algorithms used by the driver for wear leveling and block management.

The flash driver has also been redesigned to change it from the old "Flash Abstraction Layer" / "Flash Media Driver" architecture that was unique to flash drivers to a more conventional Model Device Driver / Physical Device Driver layer driver design used by the other drivers in Windows Embedded CE.

The new arrangement of the flash driver stack is shown below.

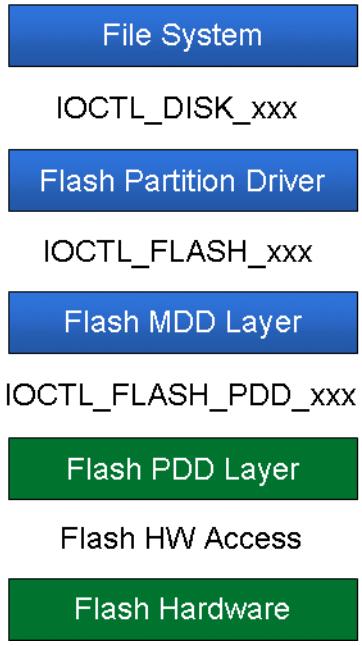

Figure 1. The flash driver stack

The flash driver stack starts with a specially-built flash partition driver that exposes a standard block driver IOCTL interface to the file system. The partition driver then talks to the MDD layer of the flash driver using a series of custom IOCTL commands. While these IOCTL commands are documented,

It's the IOCTL commands between the MDD and PDD layer that are important to OEMs writing a PDD layer to port the driver to a given flash technology. These IOCTLs are shown below.

• IOCTL_FLASH_PDD_GET_REGION_INFO	Get region information
• IOCTL_FLASH_PDD_GET_BLOCK_STATUS	Get flash block status
• IOCTL_FLASH_PDD_SET_BLOCK_STATUS	Set flash block status
• IOCTL_FLASH_PDD_READ_PHYSICAL_SECTORS	Read sectors
• IOCTL_FLASH_PDD_WRITE_PHYSICAL_SECTORS	Write sectors
• IOCTL_FLASH_PDD_ERASE_BLOCKS	Erase blocks
• IOCTL_FLASH_PDD_COPY_PHYSICAL_SECTORS	Copy sectors
• IOCTL_FLASH_PDD_GET_PHYSICAL_SECTOR_ADDRESS	Used for XIP (Only NOR flash)
• IOCTL_FLASH_PDD_LOCK_BLOCKS	Lock flash blocks
• IOCTL_FLASH_PDD_GET_LIFE_CYCLE_INFO	Get block life cycle information
• IOCTL_FLASH_PDD_GET_IDENTITY_INFO	Get Flash serial number

To aid OEMs porting their flash driver FMD layers to the new architecture, R2 provides a PDD that can link to existing FMD code so that it exposes the new IOCTL interface. This "FMD wrapper" PDD is located in the public tree under common\oak\drivers\block\msflash.

Pluggable Fonts

One of the core technologies of a WYSIWYG (What You See Is What You Get) operating system is the ability to display text in various fonts and Windows Embedded CE is no exception. Out of the box, Windows Embedded CE supports both Raster (bitmap) fonts as well as TrueType fonts. Microsoft provides a number of font files with Platform Builder and Windows Embedded CE has always been able to use third party fonts as long as they confirmed to the bitmap or TrueType font file formats supported by Windows Embedded CE.

However, there are other font standards and technologies, such as OpenType that are available through third parties. In the past, these other font file formats weren't available on Windows Embedded CE platforms since they weren't compatible with how GWES interpreted the font files.

Starting with Windows Embedded CE 6.0 R2, the graphic front end of operating system (GWES) has been redesigned to support third party font engines that can be designed to open and read fonts in any file format. This technology, called "Pluggable Fonts" frees OEMs to license third party font files in any format as long as the OEM can provide the engine to interpret the fonts.

One example of this would be OpenType. Currently, Windows Embedded CE doesn't support the OpenType font file format. Using pluggable font technology, an OEM could find a third party that has created a font engine that can be installed into Windows Embedded CE to display OpenType fonts. Another opportunity is in the area of far-eastern fonts where some companies provide better solutions for these fonts compared to what is provided by Microsoft.

Boot Loader Improvements

There are plenty of boot loader examples in the various board support packages provided with Platform Builder. One limitation of these boot loaders is the lack of support for FAT partitions that are larger than 2 GB. This limitation exists because, in previous versions of Windows Embedded CE, the boot loaders only supported FAT16 which was limited to a 2 GB partition size. For systems with moderately large hard disks, or even large flash drives, this 2 GB limit necessitates the use of a small boot partition and a large data partition.

The new boot loader provided in the CEPC BSP supports loading an operating system image from both FAT32 and ExFAT partitions. Both these partition types support partitions much larger than 2 GB which remotes the need for the small boot partition.

The new boot loader is a "BIOS loader" which means that it can be loaded directly from a custom boot sector without the need of DOS to load the image.

In addition to the new boot loader, the CEPC BSP also has a new "DiskPart" utility that can query and create hard disk partitions. This Windows Embedded CE utility provides developers easy ways to query the state of a system's hard disks as well prepare a hard disk for the BIOS boot loader. A list of the commands supported by the DiskPart utility is shown below.

Active	Mark a partition as active
Inactive	Clear the active partition flag
Create	Creates a primary partition
Delete	Deletes a partition
Clean	Deletes a partition and wipes the data
List	Lists all hard disks and all partitions
Select	Select a partition for future commands
DumpMBR	Display the master boot record data
DumpStore	Displays information about a hard disk
DumpPart	Displays information about a partition.
DumpSector	Displays information about a sector
MBRCode	Writes a file to the code area of the MBR
BootSec	Writes a file to the a boot sector of a partition
FixPartOffset	Updates the BPB of a boot sector with proper partition information
Zero	Writes zeros to all bytes in a sector

As can be seen from the list above, the DiskPart utility provides a great set of handy functions to prepare hard disks.

New Board Support Packages

The new boot loader code is part of the CEPC board support package. While the CEPC BSP hasn't been upgraded other than in the boot loader, there are three new BSPs that have been added in R2. Each of these three BSPs has been used internally by Microsoft developers to perfect specific predefined platforms that are delivered with Platform Builder.

The first BSP added to the new release is for an HP/Compaq t5530 thin client. This x86-based board support package is written for a VIA C9 CPU and contains drivers for a VIA chipset. This platform was used by the RDP team to test and verify the new remote desktop client software that is delivered with CE 6.0 R2. The BSP provides customized drivers for the video, audio, and network devices. The video driver supports hardware acceleration and video overlay features. The network driver and accompanying network KITL libraries are written to the VIA Fast Ethernet CE6B network controller.

The ST7109 BSP is an SH4-based BSP that was used to test video streaming technologies. This board support package has some interesting drivers including a custom serial ATA disk driver which is a unique implementation of a SATA driver independent of the ATA disk driver found in the public\common side of the build tree. The BSP also includes custom Video and Ethernet drivers supporting STMicro hardware.

The Marvell PXA270 BSP is a Marvell board support package supporting their newly acquired ARM XScale line. This BSP supports the PXA270 on a Marvell evaluation platform. This BSP presents

an interesting contrast to the Mainstone III BSP that was delivered in the original release of Windows Embedded CE 6.0. This new BSP includes audio and flash drivers not in the Mainstone III BSP. The BSP also includes a driver for the Philips PCF50606 power management chip which is specifically designed for power management duties for the XScale PXA270 CPU. This BSP was used by the Voice over IP team for validation of their VoIP updates that are also in CE 6.0 R2.

Conclusion

The improvements in the drivers, core, and board support packages in Windows Embedded CE 6.0 R2 provide a number of simple but welcome improvements to the operating system. These improvements, along with the updates to Internet Explorer®, RDP, and VoIP which are described in other white papers, prove that Windows Embedded CE 6.0 R2 is a great upgrade to Windows Embedded CE.

For more information:

Windows Embedded Web site:
http://www.microsoft.com/windows/embedded/default.mspx