To: T13 Technical Committee
From: Rob Elliott, HP (elliott@hp.com)
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Subject: e09127r0 EDD-4 Hybrid MBR support

Revision history
Revision 0 (24 July 2009) First revision

Related documents
d2132r0 - *Enhanced Disk Drive - 4 (EDD-4)* revision 0
Unified Extensible Firmware Interface (UEFI) SpecificationVersion 2.3 (May 2009). Chapter 5 defines the GPT disk layout and also defines the Protective MBR format. See http://www.uefi.org.

Overview
Individual 2 TB (2×10^{12}) disk drives, with a maximum LBA of 0xE8D4A510 based on 512 byte logical blocks, started shipping in 2009. The Master Boot Record (MBR) disk layout's 32-bit LBA addressing limit of 2 TiB (2×2^{40}, maximum LBA of 0xFFFFFFFF) will soon be exceeded. However, there are many operating systems still in use that do not understand GUID Partition Table (GPT) disk layouts (which fix the problem by supporting 64-bit LBAs), and there are many systems still in use with legacy BIOSes (including systems supporting hybrid UEFI/legacy BIOS operation). Allowing both legacy BIOSes and legacy operating systems to support > 2 TiB disk drives and share disks using the GPT disk layout is desired.

The Unified EFI Forum is considering a Hybrid MBR ECR that defines a new Attribute value in the GUID Partition Table (GPT) disk layout to mark a GPT partition as containing a legacy BIOS bootable partition.

New GPT-cognizant MBR boot code would be responsible for searching through the GPT to find the bootable partition, rather than selecting one of the partitions in the MBR partition table.

The UEFI specification is not a good place to define the responsibilities of legacy BIOS compatible MBR boot code, however. The EDD-4 standard is the home for legacy BIOS INT 13h function definitions, so seems like a good place to include an annex about the responsibilities of MBR boot code and VBR boot code (which invoke the INT 13h calls).

Suggested changes

Annex A
(informative)

Hybrid MBR boot code

A.1 Definitions

0.0.1 GPT disk layout: The disk layout defined by the Unified EFI specification.

0.0.2 MBR disk layout: The disk layout traditionally used by BIOS based systems.

0.0.3 Master Boot Record (MBR): The first LBA on a disk.

0.0.4 Volume Boot Record (VBR): The first LBA in a bootable partition.

0.0.5 Hybrid MBR boot code: x86 code located in the MBR that understands both the MBR disk layout and the GPT disk layout.

A.2 Acronyms

GPTGUID Partition Table

MBR Master Boot Record

VBR Volume Boot Record

A.3 Legacy MBR boot code

Legacy MBR boot code searches the MBR Partition Records for a partition with the *Boot Indicator* field set to 0x80, then loads the VBR based on the *Starting LBA* field and passes the *Size In LBA* field to the VBR.

A.4 Hybrid MBR boot code

Hybrid MBR boot code first searches the MBR Partition Records like legacy MBR boot code. If no bootable MBR partition is found, then the hybrid MBR boot code performs the following steps:

1) Use INT 13h to load the Primary GPT Header.

   LBA: 0x00000001

   Size: 0x00000001

2) Calculate the CRC32 of the GPT Header and verify that it equals the *Header CRC32* field.
3) If the *Header CRC32* field is incorrect, use INT 13h to load the backup GPT Header.

   LBA: Last LBA of the disk

   Size: 0x00000001

   NOTE 1 - Due to the limited size of the boot code, the hybrid MBR boot code may not perform all the checks that an EFI BIOS would perform.Use INT 13h to load the GPT Partition Entry Array pointed to by the selected GPT Header.

   LBA: specified in the *Partition Entry LBA* field

   Size: (*Number Of Partition Entries* * *Size Of Partition Entry*) / Logical Block Size

4) Calculate the CRC32 of the GPT Partition Entry Array and verify that it equals the *Partition Entry Array CRC32* field.
5) If the *Partition Entry Array CRC32* field is incorrect and the Primary GPT Partition Entry Array was selected, use INT 13h to load the backup GPT Header from the last LBA of the disk (see step 3) and

the backup GPT Partition Entry Array (see step 4), and calculate the CRC32 (see step 5). If the CRC32 is incorrect again, report an error and stop.

6) Search the GPT Partition Entry Array for a partition with the *Hybrid MBR Bootable* bit set to one in the *Attributes* field.
7) Use INT 13h to load the first logical block of the boot partition into memory address 0x7C00.
8) Set the x86 registers according to the Hybrid MBR Handover Procedure (see A.5) and jump to 0x7C00.

A.5 Hybrid MBR boot code handover procedure

Hybrid MBR boot code shall fill in the x86 registers according to Table A.1 before jumping to 0x7C00 if it selected a partition from GPT rather than MBR.

Table A.1 — Hybrid MBR handover x86 register values

Register	Description	Differences from legacy MBR usage
DL	Disk number	No change
ES:DI	Pointer to $PnP	No change
EAX	0x54504721 (i.e., "!GPT"). Indicates the Hybrid MBR Handover Structure is being passed with DS:SI rather than just the Legacy MBR Partition Record.	New
DS:SI	Pointer to the Hybrid MBR Handover Structure (see Table A.2)	New

Table A.2 defines the Hybrid MBR boot code handover structure.

NOTE 2 - Historically this structure included only the MBR Partition Record of the boot partition. Since the GPT partition may be located at an LBA beyond the 32-bit LBA addressing boundary, additional fields are added to communicate the full information to the VBR.

Table A.2 — Hybrid MBR boot code handover structure

Mnemonic	Byte Offset	Byte Length	Description	Differences from legacy MBR usage
Boot Indicator	0	1	Set to the *Boot Indicator* field of the Partition Record of the bootable partition (i.e., set to 0x80 (i.e., Bootable)). Set to 0x80 if the bootable partition is from GPT.	No change
Starting CHS	1	3	Set to the *Starting CHS* field of the Partition Record of the bootable partition. Set to 0xFFFFFF if the bootable partition is from GPT. The VBR should ignore this field.	No change
OS Type	4	1	Set to the *OS Type* field of the Partition Record of the bootable partition. Set to 0xED if the bootable partition is from GPT.	No change
Ending CHS	5	3	Set to the *Ending CHS* field of the Partition Record of the bootable partition. Set to 0xFFFFFF if the bootable partition is from GPT. The VBR should ignore this field.	No change
Starting LBA	8	4	Set to the *Starting LBA* field of the Partition Record of the bootable partition. Set to 0xFFFFFFFF if the bootable partition is from GPT.	No change
Size In LBA	12	4	Set to the *Size In LBA* field of the Partition Record of the bootable partition. Set to 0xFFFFFFFF if the bootable partition is from GPT.	No change
Size Of Partition Entry	16	4	Set to the *Size Of Partition Entry* field of the GPT Partition Header.	New field
GPT Partition Entry	20	Partition Entry Size	Set to the GPT Partition Entry of the boot partition.	New field

A.6 VBR boot code

The VBR boot code is responsible for booting the operating system, and is generally operating system specific.

Legacy VBR code only recognizes the MBR disk layout. The OS booted may recognize the GPT disk layout.

If EAX is set to "!GPT", then hybrid MBR cognizant VBR code shall use the *GPT Partition Entry* field and the GPT tables rather than the *Starting LBA* field and the *Size In LBA* field.