



# GPT HARD DISK DRIVES

## For HP Desktops

April 2011

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## Abstract

In order to be used in a computer system, a hard disk drive (HDD) must first be partitioned. Partitioning is done at the drive level and for many decades used the Master Boot Record (MBR) partition method. A new method called GUID Partition Table (GPT)) is now used for large-capacity drives. GPT allows for volume sizes much greater than 2.19TB, and therefore must be used on drives larger than the MBR limit of 2.19TB. This white paper describes the rationale for GPT and the types of OS, BIOS, driver, and SW tool support needed to successfully implement GPT drives in desktop systems.

## Why GPT?

HDD areal density (bits/sq in) and tracks per inch (TPI) continue to steadily increase. For 2010, many typical desktop 3.5" hard drives have areal densities and TPI that permit capacities up to 500GB per platter. In 2011, it is expected that improvements in areal density and TPI will allow drive manufacturers to begin shipping drives that have capacities of 1TB/platter. At this density, drives of 2TB and 3TB capacities become more easily producible and hence cheaper and more widely available.

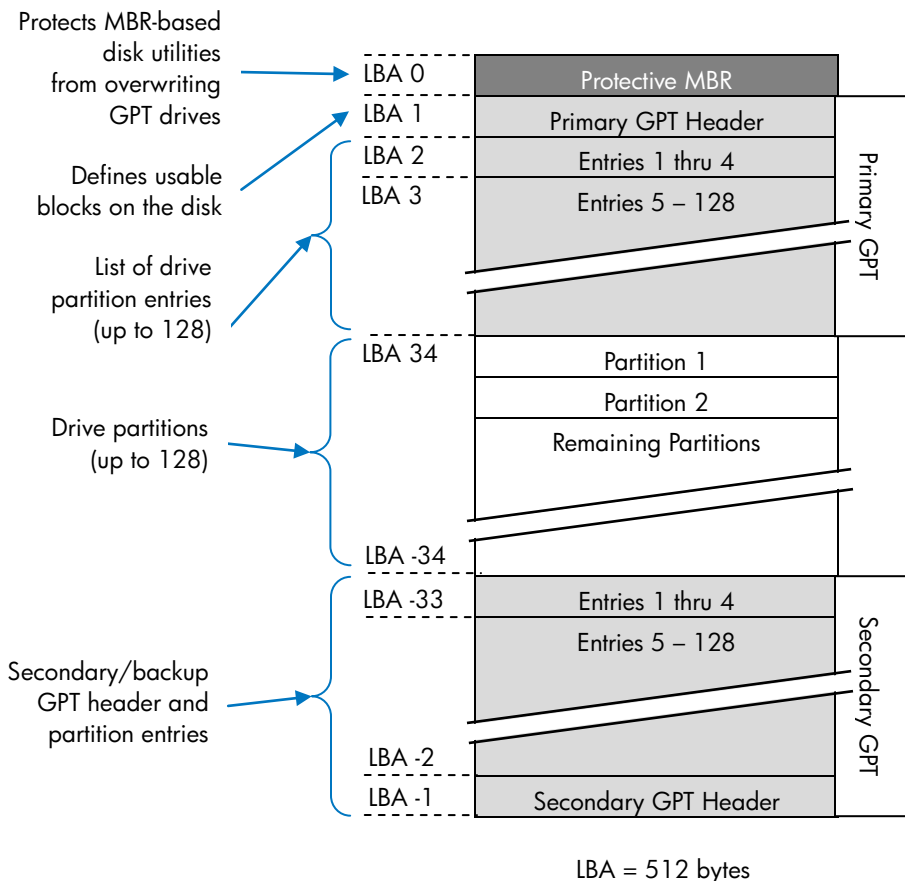
For decades, MBR partitioning was sufficient to support the amount of hard drive addressing spaces known as Logical Block Addresses (LBAs) that existed on hard drives. MBR partitioning supported 32-bit addressing and, along with 48-bit LBA extensions, was able to support drives up to a limit of 2.19TB using standard 512-byte sectors (or 512-byte sector emulation). However, now that hard drive sizes are beginning to exceed the 2.19TB limit, a newer approach is needed. GPT partitioning, which is part of the overall Unified Extensible Firmware Interface (UEFI) specification, allows for much larger hard drives than with MBR and will also allow such a drive to be bootable in a system with UEFI BIOS and UEFI-aware OS.

## GPT vs MBR

There are a number of differences between MBR and GPT. Some of the key differences include the following:

- MBR only supports 4 primary partition table entries while GPT supports 128 primary partitions with current Microsoft Windows™ operating systems.
- MBR uses 32-bit values to indicate the starting offset and length of a partition. Assuming 512 byte sectors or 512 byte sector emulation, this means an MBR disk supports  $2^{32}$  bit LBAs multiplied by 512 bytes/sectors =  $2.19 \times 10^{12}$  bytes = 2.19TB maximum disk size.
- Since GPT uses 64-bit values to indicate the starting offset and length of a partition, a GPT disk can theoretically support up to  $2^{64}$  LBAs. Assuming 512 byte sectors or 512 byte sector emulation, this means the maximum capacity of a GPT disk =  $9.4 \times 10^{21}$  bytes = 9.4 zettabytes (ZB). Microsoft Windows™ file systems design currently limits this to 256TB per drive
- GPT provides redundancy by writing the GPT header and partition table at the beginning of the disk and also at the end of the disk. If the original GPT header and partition table gets deleted or corrupted, the backup header and partition table can be used to help restore the drive. The contents of the GPT header and partition table are also verified via a CRC32 checksum for the header and one for the partition table.

Figure 1 on the following page shows a diagram of the GPT Partition Table and drive layout.



NOTE: LBA -34 refers to the 34<sup>th</sup> addressable block address counted backwards from the last LBA on the drive.

**Figure 1. GPT partition table scheme**

Figure 2 on the following page shows a comparison of the MBR and GPT layouts.

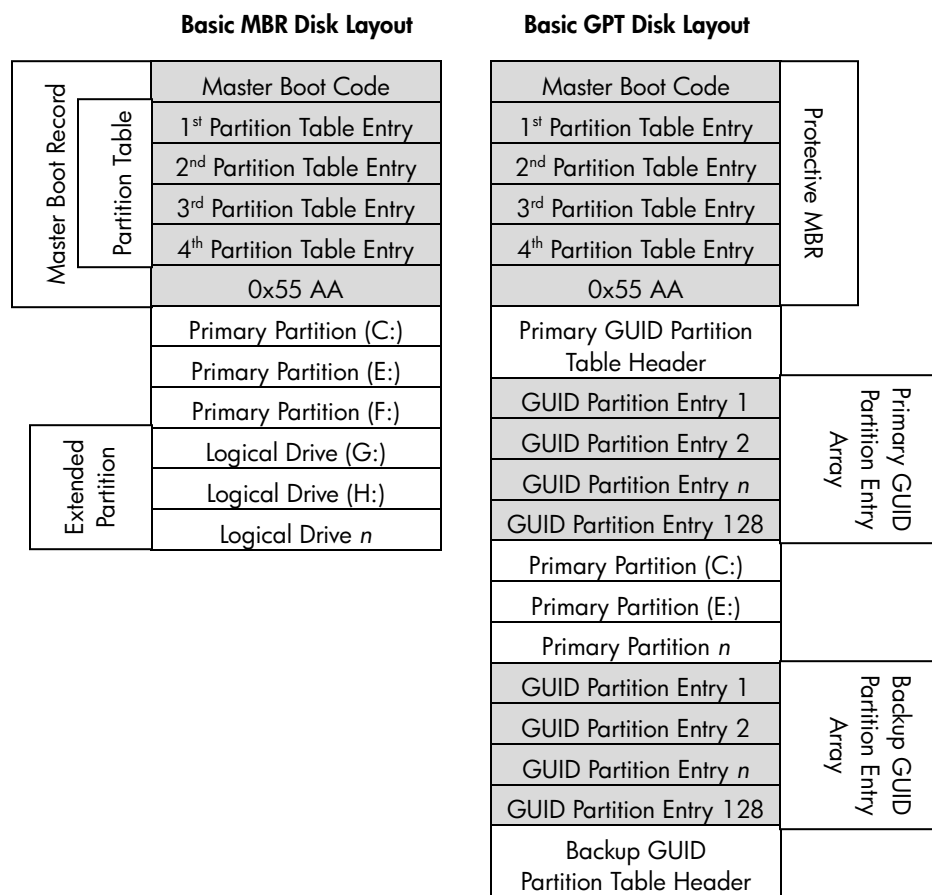


Figure 2. Comparison of MBR and GPT disk layouts

## Bootable vs Data Drives and UEFI BIOS

Since the partitions on a data-storage drive are accessed by the OS and not the BIOS, GPT drives can be used on non-UEFI systems as data-storage drives. These drives cannot, however, be used as boot drives in such systems. The legacy BIOS in a non-UEFI system cannot find the boot information on a GPT-formatted drive and therefore cannot complete the boot process into the OS. In using a GPT drive as a data-storage drive, the drive must be formatted using tools that can create GPT partitions.

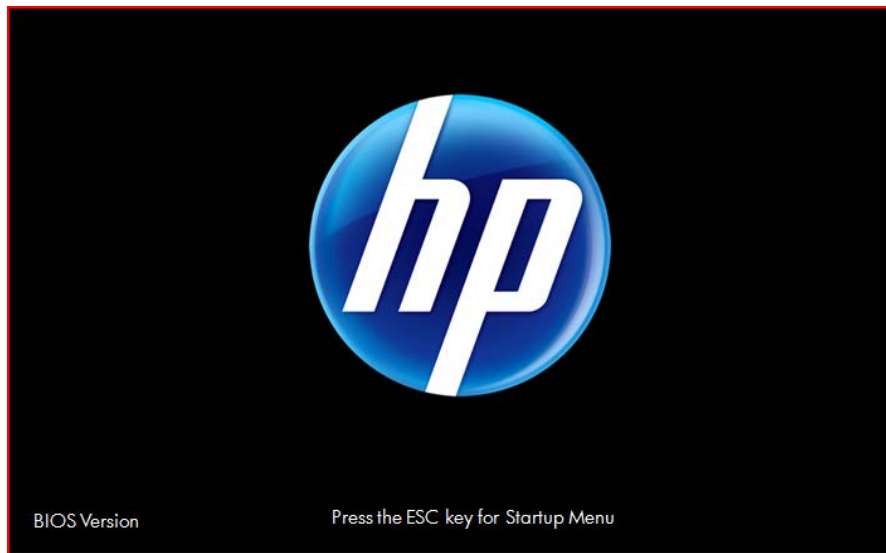
In order to boot from a GPT-formatted drive, the system must have a UEFI BIOS. UEFI understands how to find the boot information on a GPT drive. In addition, the system must also have a “UEFI aware” OS such as Microsoft Windows 7™ 64-bit. For selected desktops, HP implements the Type 0 BIOS Information data structure (as described in version 2.7 of the SMBIOS specification) to indicate UEFI BIOS support. The BIOS Characteristics Extension Bytes field within this structure has defined a bit that, if set, identifies the system as UEFI compliant. Table 1 describes BIOS Characteristic Extension Byte 2, with Bit 3 identified as the bit for UEFI specification support.

The BIOS Characteristic Extension Byte #2 is described in Table 1. Bit 3 of Byte 2 specifies UEFI specification support.

**Table 1. BIOS Characteristics Extension Byte 2**

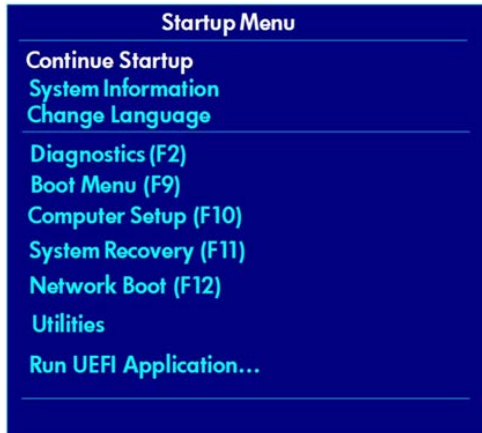
Bit Position	Description
0	When set, BIOS boot specification is supported
1	When set, function key-initiated Network Service boot is supported. When function key-initiated Network Service boot is not supported, a network option ROM may choose to offer this functionality on its own, thus offering this capability to legacy systems. When the function is supported, the network adapter option ROM shall not offer this capability.
2	When set, enables Targeted Content Distribution. The manufacturer has ensured that the SMBIOS data is useful in identifying the computer for targeted delivery of model-specific software and firmware content through third-party content distribution services.
3	When set, UEFI specification is supported.
4	When set, the SMBIOS table describes a virtual machine. When cleared, no inference can be made about the virtuality of the system.
5:7	Reserved for future assignment by this specification.

The user can determine if the system has a UEFI BIOS by looking for the splash screen during boot referencing a top-level Startup menu (Figure 3).



**Figure 3. Splash screen of HP UEFI BIOS system**

The startup menu (Figure 4) can be accessed by pressing the **Esc** key during the boot sequence.



**Figure 4. Startup Menu**

## OS Support

32-bit Microsoft Windows™ will not provide boot support for GPT. For HP desktops, bootable GPT drives and data storage drives will be initially supported under the Microsoft Windows 7™ SP1 64-bit OS. Bootable GPT drives can also be supported under the Microsoft Vista™ SP1 64-bit OS. Both of these operating systems require a UEFI BIOS to support a bootable GPT drive. Data storage-only GPT drives will be supported under 32-bit and 64-bit Microsoft Windows 7™ SP1 and can be supported under 32-bit and 64-bit Microsoft Windows Vista™. At this time, there are no immediate plans for HP Desktops to directly support GPT drives under Linux™ (HP Workstations have separate OS plans). Table 2 summarizes current OS support for HP Desktops.

**Table 2. Summary of OS support for GPT drives by HP Desktops**

Operating system	GPT Boot Support?	GPT Data Storage Support?
Windows 7™ SP1 64-bit	Yes (requires UEFI BIOS)	Yes
Windows 7™ SP1 32-bit	No	Yes
Windows Vista™ SP1 64-bit	Yes (requires UEFI BIOS)	Yes
Windows Vista™ SP1 32-bit	No	Yes
Linux™	No direct support from HP	No direct support from HP

## Storage Driver Support

Since GPT drives have capacities beyond 2.2TB, support is required through updated storage drivers. Storage driver support can be provided with certain newer operating systems' AHCI (Advanced Host Controller Interface) drivers for larger drive capacities. For improved performance, HP Desktops support GPT hard drives with storage device drivers from AMD™ and Intel™. These drivers will support both single drive implementation in AHCI and RAID 0 (striped) and RAID 1 (mirrored) formats. Expected timeframe for AHCI support is 1H 2011. Support for GPT drives in bootable RAID configurations is expected in 2H 2011.

## Imaging Tool Support for GPT

In generating SW boot images for GPT drives, the user must utilize “GPT aware” software tools. Not all tools will automatically support partitioning and formatting for GPT. For example, only newer versions of Symantec GHOST™ are able to handle GPT partition tables. The user will need to check the particular tool documentation to ensure the software provides support for GPT.

A certain percentage of users may choose to re-install the 64-bit OS with a Microsoft DVD. On machines with UEFI BIOS, the DVD setup utility may try to install the image in GPT format by default. If this is not what the user wants, then the DVD setup utility will need to be manually selected to install in MBR format instead. To install in MBR mode, the user will need to access the boot menu using F9, then select “Legacy Boot Sources/ATAPI DVD Drive/SATA0” as shown in Figure 5.

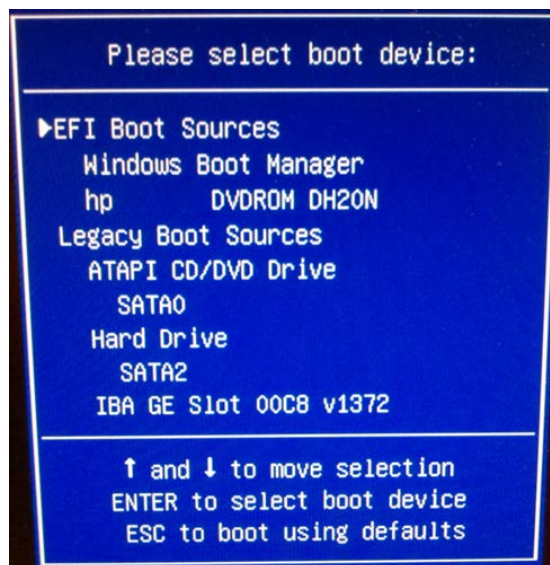


Figure 5. BIOS menu of HP UEFI BIOS system

## Drive Encryption

For Opal-based SED (Self Encrypting Drive) hard drives, UEFI protocol definitions and usage for SED are part of the UEFI v2.3.1 Spec published in Feb 2011. To ensure proper operation of Opal-based SED drives with GPT formatting, users will need to use UEFI BIOS and SED drives that conform to this version or to later versions of the UEFI specification. For all types of SED drives, the only other major requirement is that the “Shadow MBR” used in SED drives must not exceed 128MB. Since the GPT partition table is normally 15KB, this should not present a problem. Other drive encryption tools, such as McAfee Endpoint™ software encryption tools, may or may not have specific GPT support at this point. Consult the particular software vendor for details regarding planned GPT support.

## Summary

GPT-based hard disk drives offer a more consistent, scalable approach to formatting and partitioning hard drives. GPT allows more efficient use of the larger hard drives now becoming available, and also allows such hard drives to be a bootable part of a UEFI-based system. With GPT, partition and formatting support of ever-increasing drive sizes is assured for many more years.

## For more information

Additional information on topics mentioned in this document is available at the following websites:

For the UEFI specification, go to the UEFI SIG website at:

<http://www.uefi.org/home/>



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