

# GUID Partition Table

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- Unified Extensible Firmware Interface (UEFI)
- Master Boot Record (MBR)
- GUID Partition Table (GPT)

# Unified Extensible Firmware Interface

## ❑ Legacy BIOS limitations

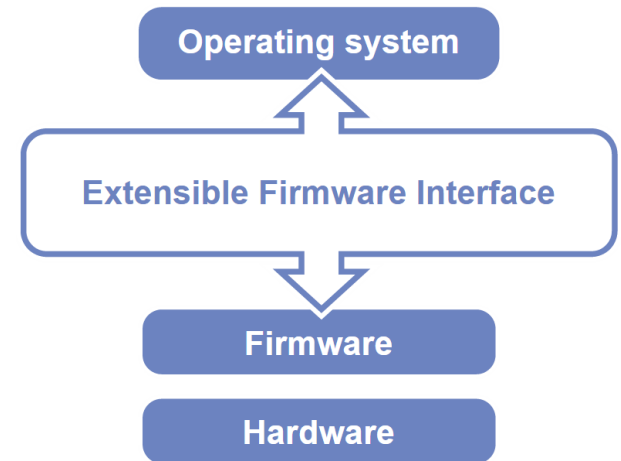
- 16-bit processor mode
- 1 MB addressable space

## ❑ Advantages

- 32-bit/64-bit processor mode
- Ability to boot from larger disk with a GPT
- Flexible pre-OS environment, including network capability
- Modular design

## ❑ Compatibility Support Module (CSM)

- BIOS-MBR
- BIOS-GPT



# Criticism - Secure Boot

- ❑ Part of UEFI spec since version 2.2
- ❑ Designed to protect normal user (?)
- ❑ Preventing unsigned OS loaders to be loaded during boot process
- ❑ FreeBSD - Not yet started

## Tasks

<b>Secure boot, unrestricted runtime</b>	
Acquire FreeBSD signing key	Not started
Port shim loader	Not started
Add mechanism to sign loader.efi	Not started
Work out to what extent loader.efi needs to be locked down, including forth code	Not started
Add documentation on creating and enrolling custom keys	Not started
Add tools for signing loader.efi and shim	Not started
<b>Secure boot, restricted runtime</b>	
Add tools for signing kernel and modules	Not started
Add code to loader.efi for kernel and module signature verification	Not started
Add code to kernel for module signature verification	Not started
Add code to kernel for prevention of user-initiated DMA	Not started



# Master Boot Record (1/2)

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- ❑ The Master Boot Record (MBR) is the first 512 bytes of a storage device

Offset	Length	Contents
0	446 bytes	Boot code area
446	64 bytes	Partition tables, each has 16 bytes
510	2 bytes	Boot signature (0xAA55)
128		Total

# Master Boot Record (2/2)

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## ❑ Drawbacks

- (4 primary partitions) or (3 primary + 1 extended partitions)
  - Arbitrary number of logical partitions within the extended partition
- The logical partition meta-data is stored in a linked-list structure
- One byte partition type codes which leads to many collisions
- Maximum addressable size is 2 TiB, i.e. any space beyond 2 TiB cannot be defined as a partition
  - MBR stores partition sector information using 32-bit LBA values
  - 512 bytes per sector
  - $2^{32} * 512 \text{ bytes} = 2 \text{ TiB}$

# Booting Process

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1. System initialization with firmware called BIOS
2. The BIOS looks for the bootloader on the MBR, then executes it
3. Bootloader reads the partition table
  - Conventional Windows/DOS MBR bootloader search for one active and primary partition
  - GRUB safely ignores this
4. Loading operating system

# GUID Partition Table (1/9)

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- ❑ GUID stands for Globally Unique Identifier
  - Ex: 3F2504E0-4F89-41D3-9A0C-0305E82C3301
- ❑ Part of the UEFI specification
- ❑ Solves some legacy problems with MBR but also may have compatibility issues
- ❑ Can be used also on BIOS system via a protective MBR

# GUID Partition Table (2/9)

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## ❑ Advantages

- Filesystem-independent
- No partition type collision because of GUIDs
- 8 ZiB
  - GPT uses 64-bit LBA
  - 512 bytes per sector
  - $2^{32} * 512 \text{ bytes} = 8 \text{ ZiB}$
- Backup header and partition table at the end of the disk
- CRC32 checksums for header and partition table

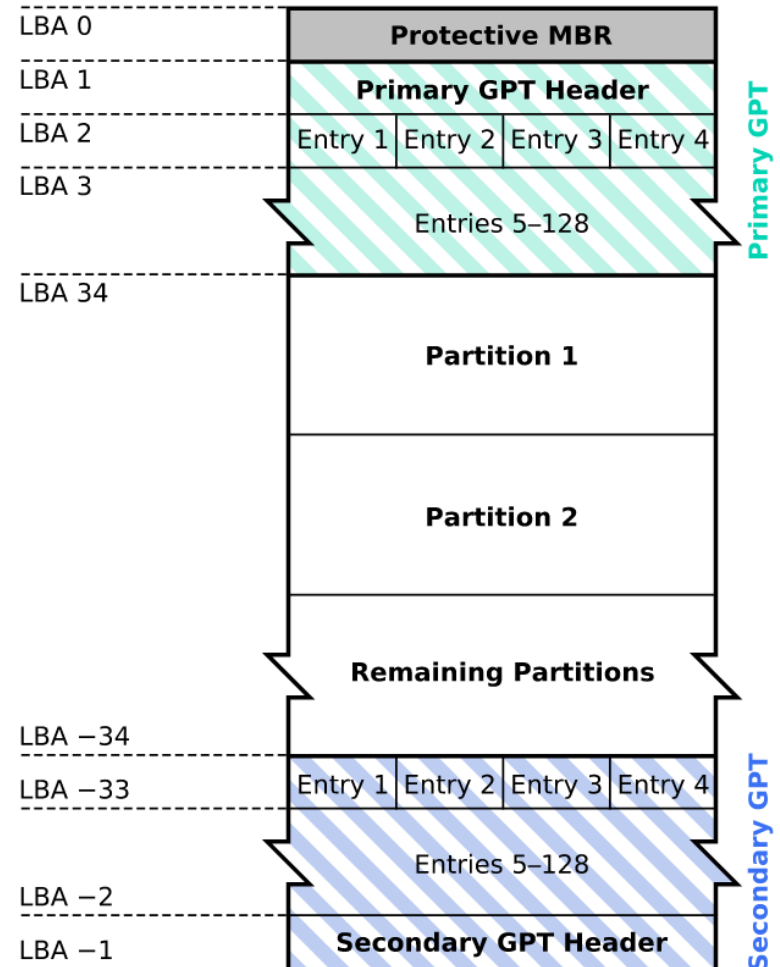


# GUID Partition Table (3/9)

## ❑ GPT Scheme

- LBA 0: Legacy MBR
- LBA 1: GPT header
- LBA 2~33: Partition entries
  - Up to 128 partitions
- LBA 34~: Partitions
- LBA -34~-1: Secondary GPT data

## GUID Partition Table Scheme



# GUID Partition Table (4/9)

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## ❑ Legacy MBR (LBA 0)

- A single partition type of 0xEE
- For OSes cannot read GPT disks: Unknown type, no empty space
- For GPT-aware OSes: check the protective MBR

# GUID Partition Table (5/9)

## ❑ GPT header (LBA 1)

Offset	Length	Contents
0	8 bytes	Signature (" <b>EFI PART</b> ", 45 46 49 20 50 41 52 54)
8	4 bytes	Revision (For GPT version 1.0 (through at least UEFI version 2.3.1), the value is <b>00 00 01 00</b> )
12	4 bytes	Header size in little endian (in bytes, usually <b>5C 00 00 00</b> meaning 92 bytes)
16	4 bytes	<b>CRC32</b> of header (0 to header size), with this field zeroed during calculation
20	4 bytes	Reserved; must be <b>zero</b>
24	8 bytes	<b>Current LBA</b> (location of this header copy)
32	8 bytes	<b>Backup LBA</b> (location of the other header copy)
40	8 bytes	<b>First usable LBA</b> for partitions (primary partition table last LBA + 1)
48	8 bytes	<b>Last usable LBA</b> (secondary partition table first LBA - 1)
56	16 bytes	Disk GUID (also referred as UUID on UNIXes)
72	8 bytes	Partition entries starting LBA (always 2 in primary copy)
80	4 bytes	Number of partition entries
84	4 bytes	Size of a partition entry (usually 128)
88	4 bytes	CRC32 of partition array
92	*	Reserved; must be zeroes for the rest of the block (420 bytes for a 512-byte LBA)

# GUID Partition Table (6/9)

## ❑ GPT header (LBA 1)

- `dd if=/dev/ada0 bs=512 count=1 skip=1 | hd`

```
# dd if=/dev/ada0 bs=512 count=1 skip=1 | hd
00000000  45 46 49 20 50 41 52 54 00 00 01 00 5c 00 00 00 |EFI PART....\...|
00000010  ad 09 1d 1d 00 00 00 00 01 00 00 00 00 00 00 00 |.....|
00000020  ff ff 7f 02 00 00 00 00 22 00 00 00 00 00 00 00 |.....".....|
00000030  de ff 7f 02 00 00 00 00 65 67 3c f3 ea 40 e4 11 |.....eg<..@..|
00000040  a2 27 55 0b 19 3d b4 a4 02 00 00 00 00 00 00 00 |.'U..=.....|
00000050  80 00 00 00 80 00 00 00 82 f4 3d 77 00 00 00 00 |.....=w....|
00000060  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 |.....|
*
00000200
```

# GUID Partition Table (7/9)

## ❑ Partition entries (LBA 2)

Offset	Length	Contents
0	16 bytes	<b>Partition type</b> GUID
16	16 bytes	Unique partition GUID
32	8 bytes	<b>First LBA</b> (little-endian)
40	8 bytes	<b>Last LBA</b> (inclusive, usually odd)
48	8 bytes	Attribute flags (e.g. bit 60 denotes read-only)
56	72 bytes	<b>Partition name</b> (36 UTF-16LE code units)
	128 bytes	Total

# GUID Partition Table (8/9)

## ❑ Partition type GUID

freebsd-boot	83BD6B9D-7F41-11DC-BE0B-001560B84F0F
freebsd	516E7CB4-6ECF-11D6-8FF8-00022D09712B
freebsd-swap	516E7CB5-6ECF-11D6-8FF8-00022D09712B
freebsd-ufs	516E7CB6-6ECF-11D6-8FF8-00022D09712B
freebsd-vinum	516E7CB8-6ECF-11D6-8FF8-00022D09712B
freebsd-zfs	516E7CBA-6ECF-11D6-8FF8-00022D09712B

# GUID Partition Table (9/9)

## □ Partition entries (LBA 2)

- `dd if=/dev/ada0 bs=512 count=1 skip=2 | hd`

```
# dd if=/dev/ada0 bs=512 count=1 skip=2 | hd
00000000  9d 6b bd 83 41 7f dc 11  be 0b 00 15 60 b8 4f 0f  |.k..A.....`.O.|
00000010  0e 99 e2 03 eb 40 e4 11  a2 27 55 0b 19 3d b4 a4  |.....@...'U..=..|
00000020  22 00 00 00 00 00 00 00  a1 00 00 00 00 00 00 00  |".....|
00000030  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  |.....|
*
00000080  b5 7c 6e 51 cf 6e d6 11  8f f8 00 02 2d 09 71 2b  |.|nQ.n.....-.q+|
00000090  98 66 a7 0f eb 40 e4 11  a2 27 55 0b 19 3d b4 a4  |.f...@...'U..=..|
000000a0  a2 00 00 00 00 00 00 00  a1 00 20 00 00 00 00 00  |.....|
000000b0  00 00 00 00 00 00 00 00  73 00 77 00 61 00 70 00  |.....s.w.a.p.|
000000c0  2d 00 30 00 00 00 00 00  00 00 00 00 00 00 00 00  |-.0.....|
000000d0  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  |.....|
*
00000100  ba 7c 6e 51 cf 6e d6 11  8f f8 00 02 2d 09 71 2b  |.|nQ.n.....-.q+|
00000110  f6 11 10 1b eb 40 e4 11  a2 27 55 0b 19 3d b4 a4  |.....@...'U..=..|
00000120  a2 00 20 00 00 00 00 00  de ff 7f 02 00 00 00 00  |..|
00000130  00 00 00 00 00 00 00 00  7a 00 66 00 73 00 2d 00  |.....z.f.s.-|
00000140  30 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  |0.....|
00000150  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  |.....|
*
00000200
```

# References

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- ❑ <http://pansci.tw/archives/8111>
- ❑ <https://wiki.freebsd.org/SecureBoot>