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Disk sector

In computer disk storage, a **sector** is a subdivision of a track on a magnetic disk or optical disc. Each sector stores a fixed amount of user-accessible data, traditionally 512 bytes for hard disk drives (HDDs) and 2048 bytes for CD-ROMs and DVD-ROMs. Newer HDDs use 4096-byte (4 KiB) sectors, which are known as the Advanced Format (AF).

The sector is the minimum storage unit of a hard drive.[1] Most disk partitioning schemes are designed to have files occupy an integral number of sectors regardless of the file's actual size. Files that do not fill a whole sector will have the remainder of their last sector filled with zeroes. In practice, operating systems typically operate on blocks of data, which may span multiple sectors.[2]

Geometrically, the word sector means a portion of a disk between a center, two radii and a corresponding arc (see Figure 1, item B), which is shaped like a slice of a pie. Thus, the *disk sector* (Figure 1, item C) refers to the intersection of a *track* and geometrical *sector*.

In modern disk drives, each physical sector is made up of two basic parts, the sector header area (typically called "ID") and the data area. The sector header contains information used by the drive and controller; this information includes sync bytes, *address identification*, flaw flag and error detection and correction information. The header may also include an

Figure 1: Disk structures:

A. Track
B. Geometrical sector
C. Track sector
D. Cluster

alternate address to be used if the data area is undependable. The *address identification* is used to ensure that the mechanics of the drive have positioned the read/write head over the correct location. The data area contains the sync bytes, user data and an error-correcting code (ECC) that is used to check and possibly correct errors that may have been introduced into the data.
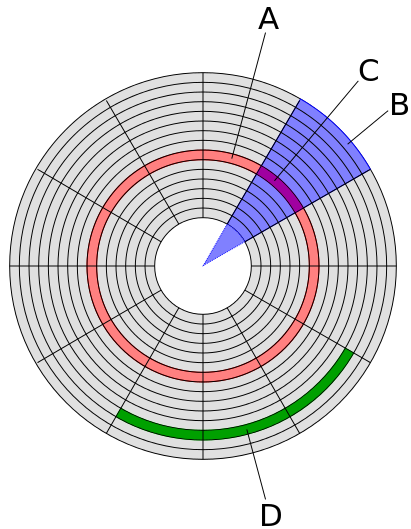
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History

The first disk drive, the 1957 IBM 350 disk storage had ten 100 character sectors per track; each character was six bits and included a parity bit. The number of sectors per track was identical on all recording surfaces. There was no recorded idenfifier field (ID) associated with each sector.[3]

The 1961 IBM 1301 disk storage introduced variable length sectors, termed records by IBM, and added to each record a record address field separate from the data in a record (sector).[4][5] All modern disk drives have sector address fields, called ID fields, separate from the data in a sector.

Also in 1961 Bryant with its 4000 series introduced the concept of zoned recording which allowed the number of sectors per track to vary as a function of the track's diameter - there are more sectors on an outer track than on an inner track.[6] This became industry practice in the 1990s and is standard today.

The disk drives announced with the IBM System/360 in 1964 detected errors is all fields of their sectors (records) with a cyclic redundancy check (CRC) replacing parity per character detection of prior generations. IBM's sectors (records) at this time added a third field to the physical sector, a key field to aid in searching for data. These IBM physical sectors, called records, have three basic parts, a Count field which acts as an ID field, a Key field not present in most disk drive sectors and a Data field, frequently called the CKD format for a record.

The 1970 IBM 3330 disk storage replaced the CRC on the data field of sector with an error correcting code (ECC) to improve data integrity by detecting most errors and allowing correction of many errors.[7] Ultimately all fields of disk sectors had ECCs.

Prior to the 1980s there was little standardization of sector sizes; disk drives had a maximum number of bits per track and various system manufacturers subdivided the track into different sector sizes to suit their OSes and applications. The popularity of the PC beginning in the 1980s and the advent of the IDE interface in the late 1980s led to a 512 byte sector becoming an industry standard sector size for HDDs and similar storage devices.

In the 1970s IBM added fixed-block architecture Direct Access Storage Devices (FBA DASDs) to its line of CKD DASD. CKD DASD supported multiple variable length sectors while the IBM FBA DASD supported sector sizes of 512, 1024, 2048, or 4096 bytes.

In 2000 the industry trade organization, *International Disk Drive Equipment and Materials Association* (IDEMA) started work to define the implementation and standards that would govern sector size formats exceeding 512 bytes to accommodate future increases in data storage capacities.[8]By the end of 2007 in anticipation of a future IDEMA standard, Samsung and Toshiba began shipments of 1.8-inch hard disk drives with 4096 byte sectors. In 2010 IDEMA completed the Advanced Format standard for 4096 sector drives,[8] setting the date for the transition from 512 to 4096 byte sectors as January 2011 for all manufacturers, and Advanced Format drives soon became prevalent.

Sectors versus blocks

While sector specifically means the physical disk area, the term *block* has been used loosely to refer to a small chunk of data. Block has multiple meanings depending on the context. In the context of data storage, a filesystem block is an abstraction over disk sectors possibly encompassing multiple sectors. In other contexts, it may be a unit of a data stream or a unit of operation for a utility.[9] For example, the Unix program dd allows one to set the block size to be used during execution with the parameter bs=bytes. This specifies the size of the chunks of data as delivered by dd, and is unrelated to sectors or filesystem blocks.

In Linux, disk sector size can be determined with fdisk -l | grep "Sector size" and block size can be determined with blockdev --getbsz /dev/sda.[10]

Zone bit recording

If a sector is defined as the intersection between a radius and a track, as was the case with early hard drives and most floppy disks, the sectors towards the outside of the disk are physically longer than those nearer the spindle. Because each sector still contains the same number of bytes, the outer sectors have lower bit density than the inner ones, which is an inefficient use of the magnetic surface. The solution is zone bit recording, wherein the disk is divided into zones, each encompassing a small number of contiguous tracks. Each zone is then divided into sectors such that each sector has a similar physical size. Because outer zones have a greater circumference than inner zones, they are allocated more sectors. This is known as zoned bit rate.[11]

A consequence of zone bit recording is that contiguous reads and writes are noticeably faster on outer tracks (corresponding to lower block addresses) than on inner tracks, as more bits pass under the head with each rotation; this difference can be 25% or more.

Advanced Format

Hard disk drive manufacturers identified the need for large sector sizes to deliver higher capacity points along with improved error correction capabilities. The traditional means of achieving storage capacity increases, which averaged 44 percent per year from 2000 to 2009, were projected to stagnate without revolutionary breakthroughs in magnetic recording system technologies. However, by modifying the length of the data field through the implementation of Advanced Format using 4096-byte sectors, hard disk drive manufacturers could increase the efficiency of the data surface area by five to thirteen percent while increasing the strength of the ECC.

See also

- CD-ROM format
- Count key data
- Cylinder-head-sector
- Disk formatting
- Disk storage
- File Allocation Table (FAT)
- Hard disk drive partitioning
- Sector slipping

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