Disk First Aid: What Does It Do? (3/96)

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TOPIC ---

What are the meanings of all the messages that appear while Disk First Aid is checking my hard drive? For what type of errors does Disk First Aid check?

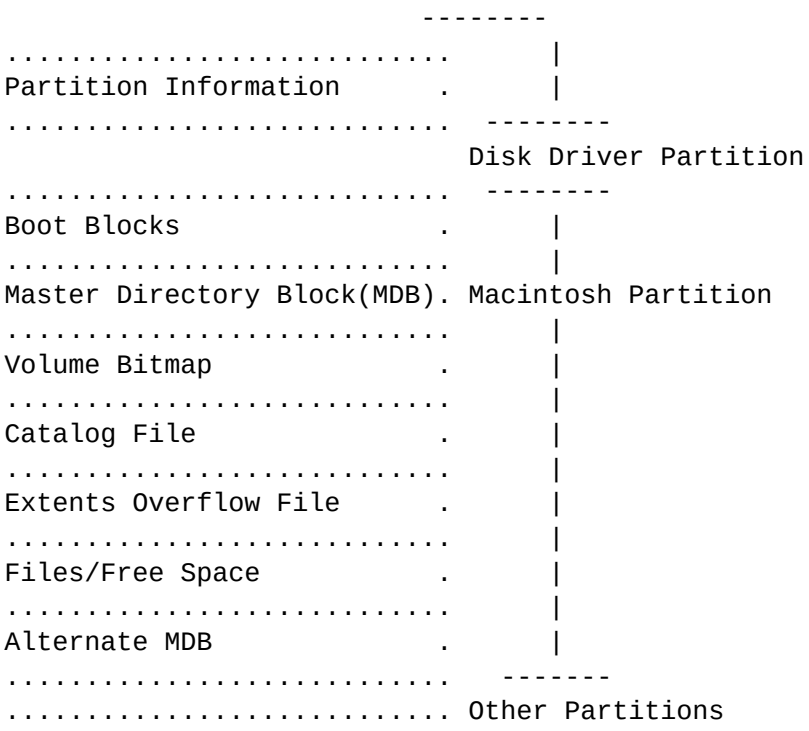
DISCUSSION ---

The information in this article is taken from the book "Inside Macintosh."

Disk First Aid ensures the integrity of individual files on a volume cataloged by Hierarchical File Structure (HFS - the method for placing data on a hard drive used by the Mac OS).

A disk can contain several partitions, which are treated as separate virtual disks by the system. Each partition contains information similar to that shown below:

Begin_Graphic



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End_Graphic

Partition Map

The first physical block (512K) contains the disk's "Partition Map". This specifies the first and last physical blocks of each partition as well as its type (Macintosh, A/UX, MS-DOS, etc.). It also contains the value for the size of "Logical Blocks.” Physical blocks are always 512K. The logical block size will vary depending upon the capacity of the drive. Whenever a file is written to the disk, it is allocated a certain number of logical blocks or “clumps.” This slows down the process of fragmentation, but can result in open space being left at the end of the file allocation.

Device Driver

After the partition map is the device driver used for SCSI communications with that device. (Note that if the device driver is updated after the drive is initialized, HFS may move the driver to the end, depending on space constraints).

Boot Blocks

The HFS volume begins with two boot blocks. This is where booting instructions are stored along with directions for locating the system and Finder files.

Master Directory Block

Contains volume information such as the date and time of volume's creation and number of files the volume contains. When the MDB is read, the volume is mounted and an area is created in memory called the Volume Control Block (VCB).

Volume Bitmap

A record of which logical blocks in the volume are allocated to files. It contains one bit for each allocation block on the volume. If the block is taken then the bit is set. Otherwise, the bit is clear if the block is available.

Catalog File/Tree

Contains hierarchical information about the relationship and structure of files and folders and their location on a volume.

Specifically, it contains the parent directory for each file. In order to determine the full path, a directory's parent is found, and so on, until the root level is reached. The Catalog File and Extents File are each in the form of a "B-Tree" (and are the source for all B-Tree type errors). See below for a discussion of B-Trees.

Extents File/Tree

An "Extent" is a contiguous range of logical blocks that are allocated to a file. The Extents File (also called "Extents Overflow File") keeps track of the location of records that can't be placed contiguously. This information is used to locate pieces of a file when it's loaded. Some Extent information is contained within the MDB and VCB. The first three file extents are always retained in memory with the VCB.

Given the above information it is understandable why optimizing, or "defragmenting" a disk is so effective. Not only does making files contiguous reduce seek time, but continual accesses to the Extents File are eliminated — all of the needed information is already in memory.

All of the items listed before the Catalog and Extents Files are contiguous. The Catalog and Extents Files can be anywhere on the volume and are not contiguous.

The Catalog File also stores Finder information for each file. This information consists of:

File Type - Identifier of one of several categories.
File Creator - Name of the application that created it.
Finder Flags - These are information items (bits) that can be set to on or off.

The Finder takes these into account when it reads them. The specific types of Finder flags are:

- isInvisible: File won't appear in dialog listings or windows.
- hasBundle: File is associated with a custom icon.
- nameLocked: File can't be renamed or have another icon assigned to it by a user.
- isStationery: File is a stationery pad.
- isShared: File is being shared over a network.
- hasCustomIcon: File has it's own customized icon.

Files Location in Window - Relative position in the window when it's opened.
Directory that Contains File - The directory path of the file.

The rest of the volume contains application/data files, the Catalog File, Extents Overflow File, and open space.

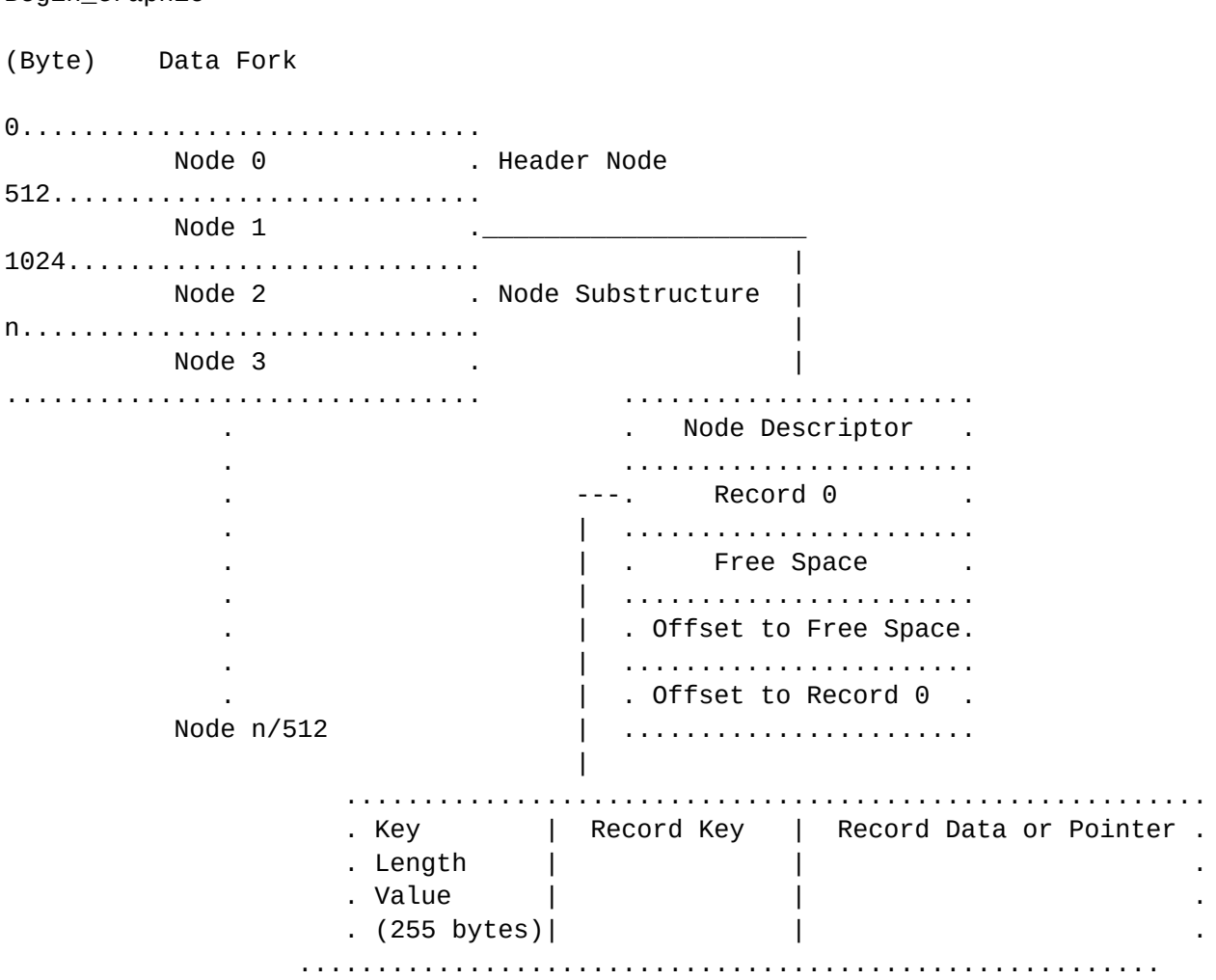
A Discussion of B-Trees

Catalog and Extents files are organized into B-Trees, a structure which allows for optimum read speeds.

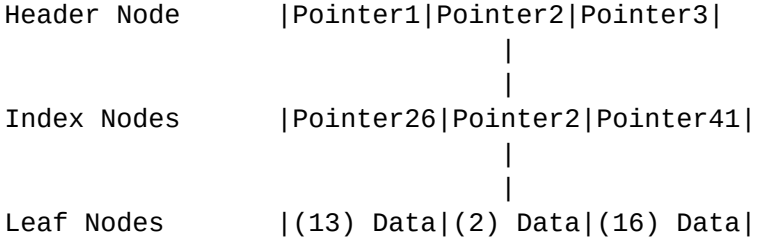
Both of these files contain only data forks — there are no resource forks. The location of the start of the Catalog and Extents B-Tree is contained at the beginning of the MDB and is stored in memory.

Below is a rough diagram of what the disk structure of the Catalog and Extents Files look like:

Begin_Graphic



An example of a B-Tree structure is shown below:



End_Graphic

This goes a long way to explain how and why errors occur. B-Tree structures are complex. If one becomes damaged, erroneous information is read into File Manager and the referenced files can also become damaged. This is why it's vital to run Disk First Aid or similar utilities on a regular basis.

Typical Errors Detected by Disk First Aid

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Below are some typical errors generated by Disk First Aid with explanations:

Keys Out of Order

B-Tree records or referenced records have become damaged.

Bad Leaf Node/Index Node

A node has been changed so it doesn't correctly refer to other nodes or records.

B-Trees Damaged

This is obvious - the B-Trees are damaged.

Volume Bitmap Incorrect

The volume bitmap does not accurately reflect the use of allocation blocks on the drive. Disk First Aid repairs this and the extents file by comparing the two with each other, then comparing against the actual allocation blocks on the drive.

Bundle Bits Need to be Reset

The Bundle Bit flag needed to reset for some of the files. (Other flags may also need to be reset).

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