Technote 1184

FCBs, Now and Forever

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CONTENTS

Mac OS 9.0 changes the format of the File Control Block (FCB) table significantly. This technote explains the original format of the FCB table, how the use of the FCB table has evolved over time, and how you can access FCB information in a compatible way.

All Mac OS developers should read the Concrete Advice section to ensure that their software is compatible with Mac OS 9.0 and beyond.

If your software is not compatible with Mac OS 9.0 (specifically, it causes a system error `119`), you should read the Debugging FCB Problems section.

The other sections of the technote are background material for the Mac OS archeologists out there.

Introduction

Prior to Mac OS 9.0, the Macintosh was limited to 348 simultaneously open files (FCBs). This limit proved to be a problem for both users and developers, so one of the design goals of Mac OS 9.0 was to increase this limit significantly. Everything has its price, however, and the price of increasing the number of FCBs is compatibility. Mac OS has used the same FCB table format since the introduction of HFS (1986) and a number of developers have (erroneously) grown dependent on this format.

Note:
The term "fork control block" is technically more accurately then the historical "file control block." To avoid confusion, this technote uses the abbreviation "FCB" everywhere.

This technote describes the changes to the FCB table format over time, and the consequences of these changes to developers. The full story is quite involved, and so the technote starts with some concrete advice for those folks with more legacy code than time.

Concrete Advice

Mac OS 9.0 is not the ultimate evolution of the FCB table. Apple expects to make further changes as the system evolves. You should look at your code now to strive for compatibility in the future.

One specific thing to check is your use of file reference numbers. File reference numbers are defined to be positive `SInt16`'s. **There are no special file reference numbers.** The number 2 is not guaranteed to be the file reference number of System file. The equality (`refNum mod` 4) = 2 (or (`refNum mod` 94) = 2, pre-Mac OS 9.0) is not guaranteed either.

Note:
The number 0 (zero) is suitable as both a nil file reference number and a nil device reference number.

For application-level software (applications, shared libraries, and so on), **the best road to future compatibility is Carbon**. The Carbon programming interfaces are specifically designed to be supportable on future systems. If you are programming for Carbon, you should be isolated from future, low-level File Manager changes.

Specifically, **if you want to access FCB information from application-level code, you should use the File Manager routine `FSGetForkCBInfo`** (or its parameter block variants `PBGetForkCBInfoSync` and `PBGetForkCBInfoAsync`, or `PBGetFCBInfoSync` and `PBGetFCBInfoAsync` on pre-Mac OS 9.0 systems).

There are, however, circumstances in which it is not possible to call the File Manager to get FCB information. For example, if you are writing a File System Manager (FSM) plug-in, or you are writing a system extension and your code is executing within the context of a File Manager patch. In these circumstances, you may need to access the FCB immediately (that is, without queuing a File Manager request).

If you need to access an FCB immediately and FSM is available, you should use the FSM accessor routines. These routines are discussed later in this technote.

The only time it is acceptable to access the FCB table directly is when you need immediate access to the FCB and FSM is not present.

Debugging FCB Problems

If your software does not work on Mac OS 9.0 and you suspect you have a dependency on the FCB table, there are a number of ways you can debug it. This section describes how you can search your source code looking for FCB-related bugs and some run-time debugging techniques you can use.

Searching Your Source Code

One obvious way to determine whether your software relies on the format of the FCB table is to run it under Mac OS 9.0. The tricky part, however, is exercising your entire source base. The FCB table dependency may be hiding in a rarely used feature that isn’t exercised by your test suite. A good alternative to testing is to search your source code looking for references to the FCB table.

For PowerPC software you should start by running your program through the Carbon Dater tool (available on the Carbon web site). This will flag any references to the FCB table low-memory accessor routines (`LMGetFCBSPtr`, `LMSetFCBSPtr`, `LMGetFSFCBLen`, and `LMSetFSFCBLen`) and likely PowerPC code sequences that indicate a low-memory access. Unfortunately, Carbon Dater cannot detect all low-memory accesses, so you should search your source code textually as well.

Carbon Dater is not an option for 68K software, so the best thing to do is search your source code looking for some (uncommon) strings that indicate direct access to the FCB table. The strings to look for are:

- “FCBSPtr” and “FSFCBLen”—The official names for the key low-memory globals.
- “34E” and “3F6”—The above in hexadecimal.
- “846” and “1014”—The above in decimal.

If you don’t have source for all of your software, you can also search your 68K code resources for `$034E` and `$03F6`. Both of these values are rare as 68K instructions, so if you hit one, it is worth disassembling the surrounding code to see whether it is an FCB table access.

System Error 119

If you run your software and the system crashes with a system error `dsMustUseFCBAccessors` `119`, it is a sure sign that your PowerPC code is accessing the FCB table directly. See PowerPC Code and Low-Memory Accessors for details.

Horrible Crashes

If your application dies with an **access exception** (or **bus error**) on Mac OS 9.0, you can look at the program state to determine whether the problem is FCB related. Any of the following in your Processor registers or local variables might indicate FCB-related troubles.

- Pointers in to the 32-KB pointer block referenced by the low-memory global `FCBSPtr ($034e).`
- Values of `$68F168F1`, possibly shifted in either direction by 16 bits. This is the bus error value which the File Manager uses to fill unused entries in the fake FCB table. See 68K Code and Low Memory for details.
- Values that are the address of a VCB (using MacsBug's `vol` command to display the VCB list), possibly shifted in either direction by 16 bits. 68K Code and Low Memory explains why this is likely.

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Before the Beginning

FCBs, as we know them today, were introduced as part of HFS. HFS is built in to all 128K ROMs or later (starting with the Macintosh Plus in 1986), and was available as an extension for 64K ROM computers (the Macintosh 128 and 512).

Except for a few corner cases, this technote assumes that you are programming for a 128K ROM system or later. This is a fair assumption because 64K ROM machines do not support System 7.0. Moreover, no current development environment supports development for 64K ROMs. In short, if you are developing for the 64K ROM, you have our sympathy but not our support.

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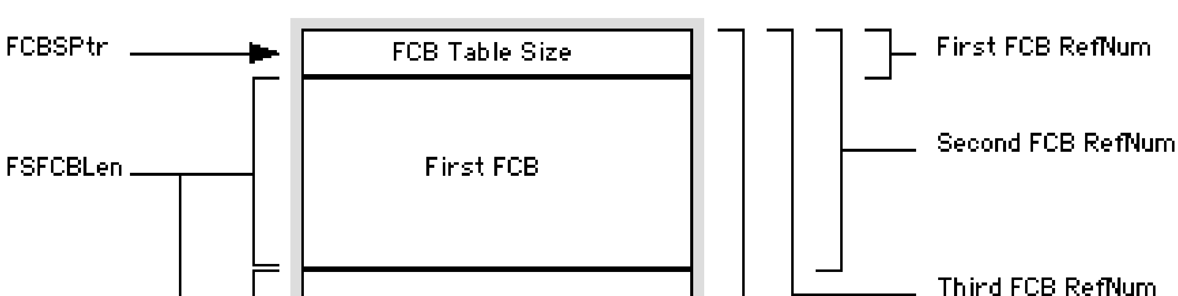
In the Beginning

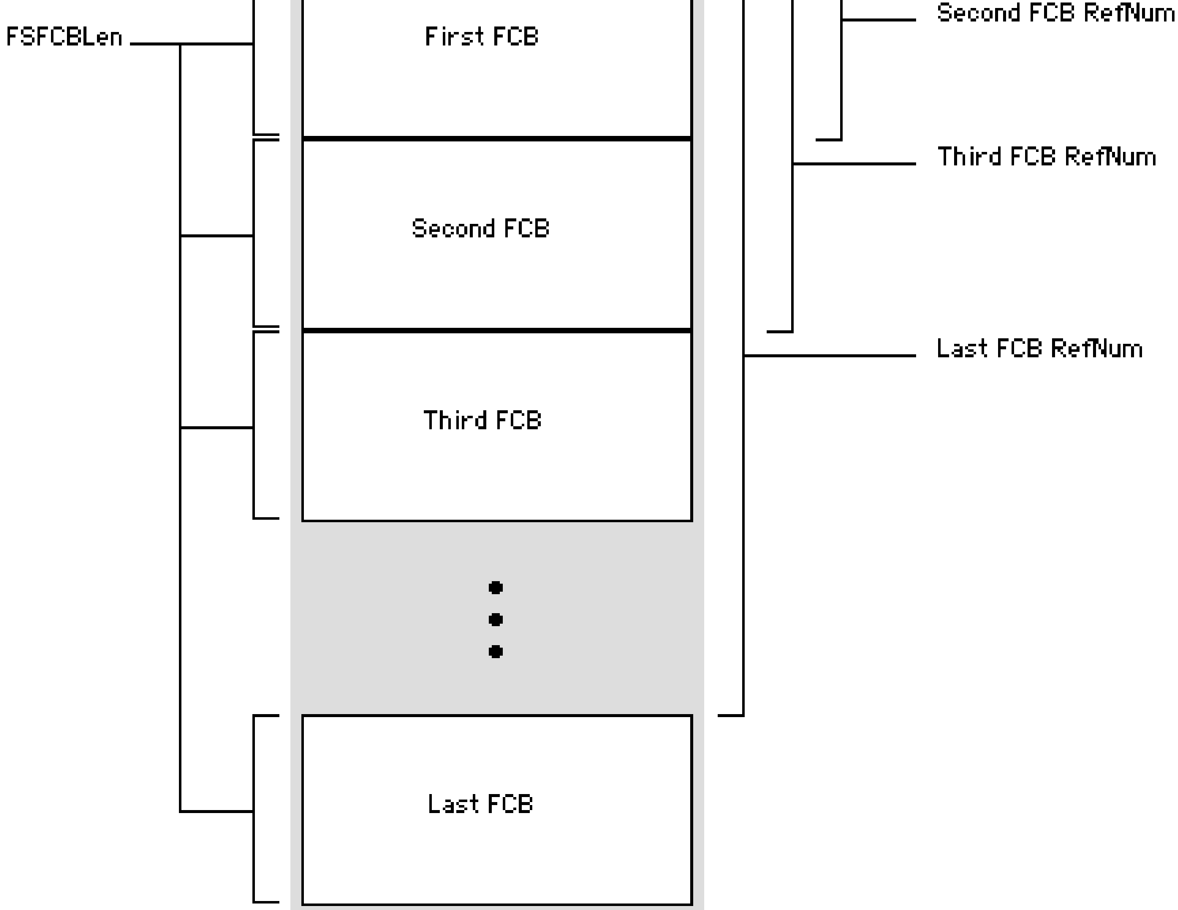
This section described the classic FCB table format, which was introduced with the HFS file system and retired in Mac OS 9.0. It also discusses some of the limitations of this format.

Classic FCB Table

When it was introduced, HFS used an simple table to store FCBs. The table is held in a pointer block in the system heap and is pointed to by the low-memory global `FCBSPtr` ($34E). The table consists of a two byte header (which contains the size of the pointer block) followed by an array of FCBs, each of which is a fixed size. This size is determined by another low-memory global, `FSFCBLen ($3F6)`, which contained the value `94` when HFS was introduced.

The format of the classic FCB table is shown in below.





A file reference number is the offset into this table of the corresponding FCB. The file reference number for the 'Nth file is 2 + (N - 1) * `FSFCBLen`, which yields the sequence 2, 96, 190, 284, and so on.

FCB Table Design Limitations

The basic structure of the FCB table implies a limit to the number of FCBs, and hence the number of simultaneously open files. The original Macintosh (which was extremely memory constrained) created a table with 10 FCBs. This number was derived from the `bbCntFCBs` field of the boot block ([`BootBlkHdr`]). When the Macintosh Plus was introduced, the system automatically scaled this number to suite the installed memory. If the computer had 1 MB or more, the system created an FCB table with `bbCntFCBs` * 4 entries. The result was an FCB table with 40 entries on most System 6 computers.

Towards the end of System 6's lifespan, this limit proved to be a problem for many users. There were two solutions. First, one could use a disk editor (the legendary FEdit, for example) to increase the limit by editing the boot block. Second, one could install the "Up Your FCBs" system extension, which would expand the FCB table to its maximum size at system startup.

The maximum size of the classic FCB table is 32 KB, primarily because a file reference number is a 16-bit signed offset into the table. This yields a maximum number of FCBs of (32768 - 2) div `FSFCBLen`, or 348 for the standard FCB size of 94 bytes.

Note:
Inside Macintosh: Files states that the maximum number of open files with the classic FCB table is 342. This is incorrect. **The limit is 348.**

Note:
The maximum number of FCBs is not the same as the maximum number of files an application can open. The system uses some of these FCBs for its own internal needs. Some of this usage is an unavoidable implementation detail of the file system (such as the FCBs for the HFS catalog and extents files), while other files are explicitly opened by system software (such as the System file and various shared libraries). Modern systems maintain a lot of open files and severely constrain the number of

FCBs available to application software. For example, an easy install of Mac OS 8.6 has 100 files open before you get to the Finder.

Compatibility Notes

The classic FCB table was never a public data structure. While the format is well known—it is described in Technote 1089, "HFS Elucidations Revisited"—all these descriptions include a warning that relying on this format will cause future compatibility problems.

There is, however, one documented use of the `FSFCBLen` low-memory global, namely to determine whether the system has HFS available. This mechanism is described in Technote FL_35, "Determining Which File System Is Active." This technique requires that `FSFCBLen` be positive if HFS is available, and negative otherwise. **There is no documented use of `FSFCBLen` other than testing its sign.**

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System 7.0

System 7.0 introduced a number of new file system features related to FCBs. This section describes those features. Remember that all versions of System 7 and Mac OS 8 use the classic FCB table format, and inherit many properties from that format.

Parallel FCB Table

System 7.0 was the first system to track FCB usage by process. When a process opens a file, the FCB is tagged as belonging to that process. If the process quits unexpectedly, the Process Manager automatically closes all the FCBs owned by it.

Unfortunately, there was not enough space to store the `ProcessSerialNumber` (PSN) of the owning process in the classic FCB. While it was possible to grow the FCB (by changing `FSFCBLen`), this had two important drawbacks.

1. Increasing the size of an FCB would decrease the maximum number of FCBs, because the maximum overall size of the classic FCB table size is limited to 32 KB.
2. Increasing the size of an FCB might cause compatibility problems for developers who had hard-coded `sizeof(FCBRec)` into their code (bad developers!).

Instead, System 7.0 introduced the concept of a parallel FCB table. This table was used to store the PSN for the process that opened the file and, when a process quit, to close all the files that were left open by that process.

IMPORTANT:
The parallel FCB table was never documented to third-party developers and has been removed in Mac OS 9.0. It is discussed here for informative purposes only and you should not rely on any details of the table or its implementation.

Process Manager only tracks files that are opened synchronously. Files that are opened asynchronous (using `PBHOpenDFAsync`, for example) are not tracked by the Process Manager because these calls can be made at interrupt time, and there is no easy way to determine the owning process at interrupt time.

Dynamically Growing FCB Table

System 7.0 also introduced a mechanism to grow the FCB table dynamically. When a program attempts to open a file while the FCB table is full, the system returns a `tmfoErr` (-42). When this happens under

System 7.0, the system catches the error, attempts to grow the FCB table, and then retries the open. The system can only grow the FCB table if all of the following are true.

- The request to open a file was made synchronously. Asynchronous requests (using `PBHOpenDFAsync`, for example) can potentially be made at interrupt time, when it is illegal to call the Memory Manager to grow the FCB table.
- There is enough space in the system heap for the new table.
- The table is smaller than its maximum of 348 FCBs.

Because of these restrictions, it is still possible to get a `tmfoErr` error under System 7.0 and later, although you are unlikely to get one if you are opening the file synchronously unless the FCB table is completely full.

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System 7.5

System 7.5 was the first system to include the File System Manager (FSM) as part of the System file. FSM provides a number of routines which allow you to access FCBs without assuming knowledge of the FCB table format.

The four FCB accessor functions are:

1. `UTResolveFCB`, which maps a file reference number to an FCB
2. `UTIndexFCB`, which indexes through the open FCBs on a volume
3. `UTLocateFCB`, which finds an FCB by file number and volume
4. `UTLocateNextFCB`, which finds additional FCBs (after using `UTLocateFCB`) by file number (or name) and volume

These routines are documented in the “Guide to the File System Manager”, which is part of the File System Manager SDK.

IMPORTANT:
These FCB accessor routines are not in InterfaceLib prior to Mac OS 8.5. The MoreInterfaceLib module of the DTS sample code MoreIsBetter has Mixed Mode glue for calling these routines from CFM code on earlier systems.

IMPORTANT:
In Mac OS 9.0, `UTIndexFCB` will also return iterator control blocks. If you are only interested in open files, you must explicitly skip these iterator control blocks using the technique described below.

Note:
These FCB accessor routines are not part of Carbon. Carbon code does not have immediate access to FCBs; see the Concrete Advice section for details.

These FCB accessor routines were originally intended for use by FSM plug-ins (and other foreign file systems) but it is appropriate to use them in other code. However, before you use these routines you should read the Concrete Advice section to see whether you would be better off using File Manager routines instead (for example, `FSGetForkCBInfo`).

You can test for the availability of these accessors with the following code.

```
static Boolean HasFCBAccessors(void)
{
    Boolean result;
    long    response;
```

```
    result = false;

    // Make sure FSM is installed

    if ( Gestalt(gestaltFSAttr, &response) == noErr ) {
        if ( (response & (1L << gestaltHasFileSystemManager)) != 0 ) {

            // FSM 1.2 is the first version to support the
            // the documented API, so check the version

            if ( Gestalt(gestaltFSMVersion, &response) == noErr ) {

                // Make sure we have FSM 1.2 or later

                if ( (unsigned long)response >= 0x0120) {
                    result = true;
                }
            }
        }
    }
    return result;
}
```

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Mac OS 8.1

Mac OS 8.1 introduced a new, built-in volume format, HFS Plus. Despite significant changes to the internals of the File Manager, Mac OS 8.1 changed the FCB table very little.

The most important change was required because HFS Plus needs more space to store its extents information. The classic FCB table stores the first 3 extents of a file in the `fcbExtRec` of the FCB, where each extent is a 16-bit allocation block number and a 16-bit length. HFS Plus needs to store the first 8 extents of a file, where each extent is a 32-bit allocation block number and a 32-bit length. Obviously the new extent data would not fit into the classic FCB.

The solution adopted was to store the extents data for files on HFS Plus volumes in the parallel FCB table, leaving the `fcbExtRec` field of the FCB unused (and set to zero). This was a very compatible solution because it left the classic FCB table mostly unchanged. Only software that relied on `fcbExtRec` broke, and that software would have broken anyway because of the new, larger, allocation block numbers.

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Mac OS 9.0

This section describes the features of the Mac OS 9.0 File Manager as they relate to FCBs. It also explains some of the rationale behind the changes made in Mac OS 9.0. It even explains why the new limit to the number of open files is 8,169!

Design Goals

Mac OS 9.0 includes a significant enhancements to the File Manager, including:

- new programming interfaces to access HFS Plus features such as long file names (255 Unicode characters) and large files (> 2 GB)

- a new FCB table format that extends the limit of the number of open files from 348 to 8169
- the ability to make most File Manager calls from pre-emptive tasks (MP tasks)

One of the design criteria for the enhanced File Manager was to implement these new features without breaking software that uses documented programming interfaces. Increasing the maximum number of open files required a change to the FCB table format, but this format has never been documented as something that developer can rely on.

Note:
Developers have been warned to not rely on the format of the FCB table many times.

- *Inside Macintosh II*, page 127, “Warning: The size and structure of a file control block may be different in future versions of Macintosh system software.”
- *Inside Macintosh IV*, page 181, “Warning: The size and structure of a file control block may be different in future versions of Macintosh system software.”
- *Inside Macintosh V*, page 386, “Do not directly examine or manipulate system data structures, such as file control blocks (FCB) or volume control blocks (VCB), in memory. Use File Manager calls to access FCB and VCB information.”
- Inside Macintosh: Files, page 2-81, “Note: The size and structure of a file control block may be different in future versions of Macintosh system software. To be safe, you should get information from the FCB allocated for an open file by calling the File Manager function `PBGetFCBInfo`.”
- Technote 1089, “HFS Elucidations Revisited.” “The following example is here for illustrative purposes only; dependence on it may cause compatibility problems with future system software.”

Gestalt

Mac OS 9.0 defines a new `Gestalt` bit which indicates that the system has a new FCB table format and that you can’t rely on `FCBSPtr`, `FSFCBLen`, or their low-memory accessor routines (except `LMGetFSFCBLen`). This `Gestalt` bit is `gestaltMustUseFCBAccessors` (bit 13) of `gestaltFSAttr`. As a rule, you should not use this `Gestalt` bit to determine whether to use FCB accessors; instead, you should always use the FCB accessors if they are available.

Big Changes

In Mac OS 9.0, FCB information is now stored in a private table whose format is undocumented to developers.

The information that was previously stored in the parallel FCB table has been rolled into an expanded FCB. The expanded FCB is defined by the `ForkControlBlock` type in “FSM.h.”

Mac OS 9.0 also stores iterator control blocks in the FCB table. See Iterator Control Blocks for details.

Developers who need immediate access to FCBs must use the FSM accessors. In addition, Mac OS 9.0 introduces more FSM accessor routines, described in the New FSM Accessors section.

68K Code and Low Memory

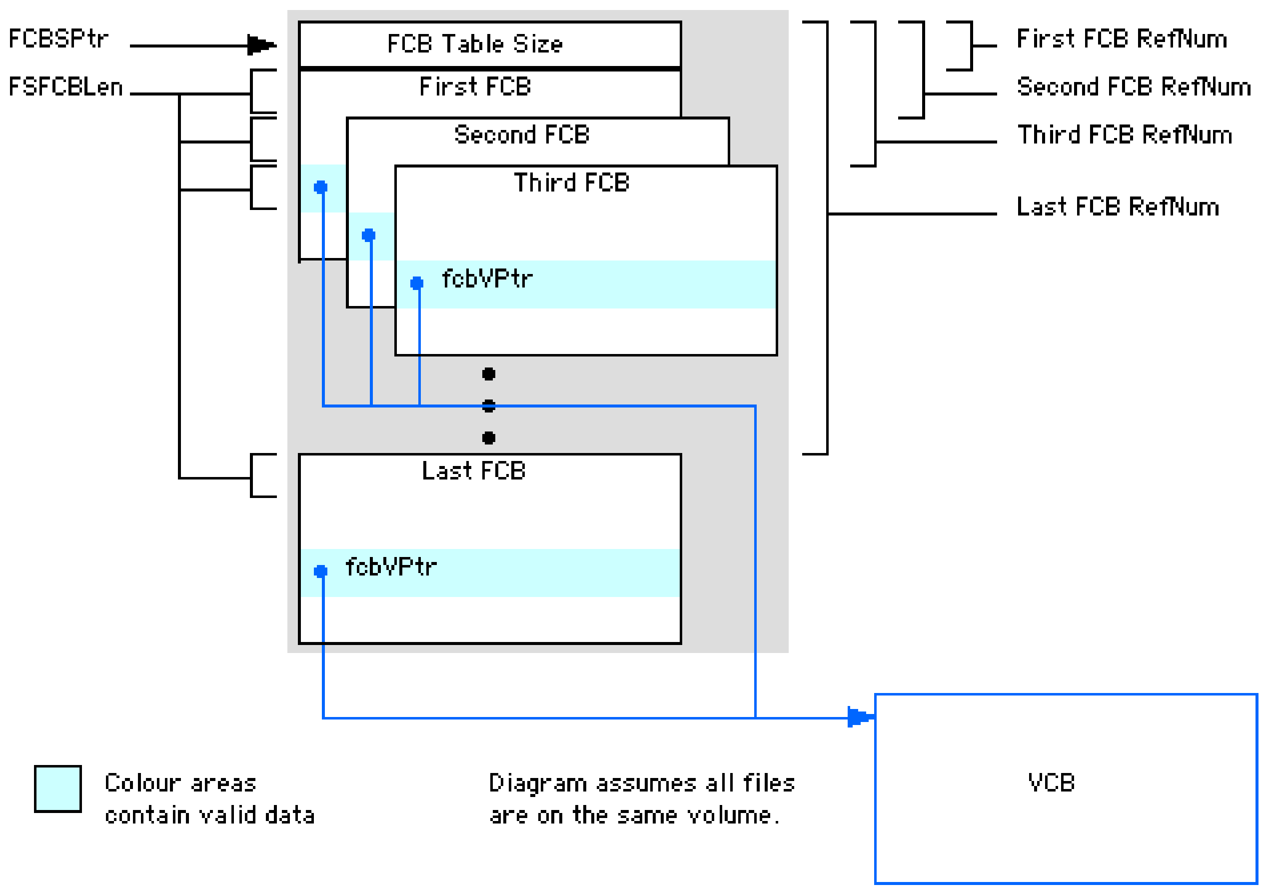
Given the massive changes to the FCB table format, it is clear that the low-memory globals associated with the classic FCB table format (`FCBSPtr` and `FSFCBLen`, describe above) no longer have any meaning. Apple originally intended to set these variables to a value that would cause a bus error if accessed, but a number of considerations have modified this policy.

Unfortunately, the Apple-supplied glue for `GetVRefNum` relies on the classic FCB table format. This glue is statically linked into many 68K applications, and prevents Apple from eliminating the classic FCB table completely. Instead, a fake FCB table is carefully constructed so that this glue continues to work.

Note:
The Apple-supplied glue for `GetVRefNum` has made its way into a number of different libraries in a number of different development environment.

- MPW includes `GetVRefNum` in “Interface.o.”
- CodeWarrior includes `GetVRefNum` in “MacOS.lib.”
- Think C and Symantec C include `GetVRefNum` in “MacTraps.”
- Think Pascal includes `GetVRefNum` in “Interface.Lib.”

The fake FCB table is pointed to by `FCBSPtr` as before, but `FSFCBLen` is set to 4. The table is make up of fake FCBs, one for each real FCB on the system. The fake FCBs are staggered by `FSFCBLen` (4 bytes) and each contains a valid `fcbVPtr` at an offset of 20 ($14) bytes into the fake FCB ($10 bytes beyond the bounds of the FCB as reported by `FSFCBLen`). The following diagram illustrates this layout.



This layout allows the `GetVRefNum` to look up the FCB table, check that the file reference number is valid, and look up the `fcbVPtr` field of the FCB, all using the fake FCB table.

Note:
The disassembly of the GetVRefNum glue from "Interface.o" is shown below.

```
; function GetVRefNum(fileRefNum: integer; VAR vRefNum: integer): OSErr;

GetVRefNum
        MOVEA.L    (A7)+,A1          ; pop return address
        MOVEQ      #$00,D1           ; get fileRefNum (zero extended)
        MOVE.W     $0004(A7),D1      ;
```

```
        MOVEA.L    FCBSPtr,A0        ; get FCB table pointer
        MOVE.W     FSFCBLen,D0       ; and FCB size
        BMI.S      NoHFS             ; if negative, we're pre-HFS
@HFS
        DIVU.W     D0,D1             ; divide fileRefNum by FSFCBLen
        BRA.S      DoneDivision
@NoHFS
        DIVU.W     #$005E,D1         ; divide fileRefNum by size of
                                     ; pre-HFS FCB
@DoneDivision
        SWAP       D1                ; get fileRefNum mod FCB size
        SUBQ.W     #$2,D1            ; if fileRefNum mod FCB size
        BNE.S      BadResult         ; not 2, error out

        MOVE.W     $0004(A7),D0      ; if fileRefNum > than size
        CMP.W      (A0),D0           ; of FCB table,
        BCC.S      @BadResult        ; return an error

        MOVEA.L    $14(A0,D0.W),A0   ; grab fcbVPtr from appropriate
                                     ; FCB, points to VCB
        MOVE.W     $004E(A0),D0      ; grab vcbVRefNum from VCB
        MOVEQ      #$00,D1           ; noErr
        BRA.S      @GoodResult

@BadResult
        MOVEQ      #$00,D0
        MOVE.W     #$FFCD,D1         ; rfNumErr

@GoodResult
        MOVEA.L    (A7),A0           ; put D0 into vRefNum
        MOVE.W     D0,(A0)           ;
        ADDQ.W     #$6,A7            ; pop params
        MOVE.W     D1,(A7)           ; put D1 into function result
        JMP        (A1)              ; return to caller
```

Note:
The fake FCB table is the cause of the 8169 limit on the number of open files. As before, the fake table is limited to 32 KB. No FCB is placed beyond the last 94 bytes because it might cause code that is walking the FCB table to wrap an `SInt16`. Therefore, the number of fake FCBs available is (32768 - 94 - 2) div 4 + 1, or 8169.

PowerPC Code and Low-Memory Accessors

The case for PowerPC code is somewhat clearer. For PowerPC code, the implementation of `GetVRefNum` is part of the system software, so it was modified to cope with the new FCB table format.

On the other hand, the low-memory accessor routines for `FCBSPtr` and `FSFCBLen` presented a more interesting problem. In theory, developers shouldn't be using these routines because they shouldn't be depending on the format of the FCB table. In practice, our experience is that a surprising number of popular applications were using them. This forced Apple to make a decision as to what these routines should do.

The final decision is:

- `LMGetFCBSPtr`, `LMSetFCBSPtr` and `LMSetFSFCBLen` all raise a `dsMustUseFCBAccessors` (119) system error
- `LMGetFSFCBLen` continues to return the value from `FSFCBLen`, which is now 4.

The rationale for these changes was:

- The format of the FCB table (as pointed to by `FCBSPtr`) has radically changed. Any software relying on this format is not going to work. Given that the software is not going to work, it is much better for the software to halt sooner rather than later. This prevents possible data loss caused by old software modifying what it thinks is the FCB table.
- The distinctive system error number allows technical support folk to quickly diagnose this problem.
- `FSFCBLen` has a documented use (to test for the presence of HFS, as described earlier) and continues to work for that use.

Iterator Control Blocks

The File Manager in Mac OS 9.0 introduces a new mechanism, the iterator, to find all the items in a directory or on a volume. An **iterator** is an abstract object used to hold the state of a particular bulk catalog operation. An iterator is described by the `FSIterator` data type, which is created with `FSOpenIterator` and destroyed with `FSCloseIterator`.

On traditional Mac OS, the state for the `FSIterator` is maintained in an **iterator control block** (of type `IteratorControlBlock`) in the FCB table. The iterator control block is like an FCB except that it maintains the state for an `FSIterator` instead of for an open file.

Any software that uses FSM accessors must be careful to treat iterator control blocks as such, and not to blindly treat them as FCBs. You can distinguish between an `IteratorControlBlock` and a `ForkControlBlock` by testing the `fcbIteratorBit` in the `moreFlags` fields of the FCB.

IMPORTANT:
The `moreFlags` field of the FCB is not present prior to Mac OS 9.0. You should conditionalize your test for iterator control blocks using Gestalt.

New FSM Accessors

Mac OS 9.0 introduces a number of new FSM utility routines which supplement the routines described earlier. The routines are:

- `UTGetForkControlBlockSize`—Returns the size of an FCB. This routine is necessary because `LMGetFSFCBLen` is no longer useful and it is expected that the FCB will expand further as the system evolves.
- `UTResolveFileRefNum`—Returns the file reference number for a given FCB.
- `UTCheckFCB`—Allows you to validate whether an `FCBRecPtr` points to a valid FCB.
- `UTCheckForkPermissions`—A replacement for `UTCheckPermission` that is somewhat easier to use.

In addition, FCBs are now placed in a search list to speed up the search for open files. The following routines allow an external file system to benefit from the speed gains of this search list.

- `UTAddFCBToSearchList`
- `UTRemoveFCBFromSearchList`
- `UTLocateFCBInSearchList`

All of these routines will be further documented in an update to the “Guide to the File System Manager.”

Note:
These FCB accessor routines are not part of Carbon. Carbon code does not have immediate access to FCBs; see the Concrete Advice section for details.

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Summary

The format of the FCB table, while documented to developers for illustrative purposes, have never been guaranteed. Mac OS 9.0 changes the format of this table, primarily to increase the maximum number of open files on the system. Apple has made this change such that all existing, documented programming interfaces continue to work. Moreover, the existing FSM accessors (introduced with System 7.5) allow immediate access to an FCB in places where this is necessary. However, Apple strongly recommends that developers avoid immediate access to FCBs and instead use the Carbon-compatible File Manager programming interfaces.

Further References

- Inside Macintosh: Files, especially the File Control Blocks section
- *Guide to the File System Manager*, part of the File System Manager SDK
- Technote 1089, HFS Elucidations Revisited
- Technote FL_35, Determining Which File System Is Active
- Technote 1176, Mac OS 9.0
- Technote 1121, Mac OS 8.1
- Technote OV_21, System 7.5
- Technote 1150, HFS Plus Volume Format
- Q&A FL_10, Accessing File Control Blocks
- Carbon web site

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Downloadables

Acrobat version of this Note (98K).

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Updated: 05-October-1999