PATHWORKS File System

Personal Computer Systems Group

Abstract

This specification contains the function description of the PATHWORKS File System (PFS) and standard file system libraries.

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1 PREFACE

2 REVISION HISTORY

Michael Evans	0.0	21-Apr-1992	Initial creation
Michael Evans	0.1	3-Aug-1992	Revise structure of document and add design details
Michael Evans	1.0	19-Oct-1992	Update function descriptions, add PFS_checksecurity(). Redefine PFS structures.
Michael Evans	1.1	30-Oct-1992	Add FSLIB_opendesc() and FSLIB_closedesc(). Update descriptions.
Michael Evans	1.2	5-Nov-1992	Add FSLIB_fextend(), changed font size so I can read it!
Michael Evans	2.0	20-Jan-1993	Updated to reflect Base Level 2 release.
Michael Evans	3.0	8-May-1993	Updated to reflect Base Level 3 release. Added PFS_pathfunc(), PFS_timefunc(), changed return status codes, eliminated PFS_errno
Michael Evans	4.0	24-May-1993	Updated to reflect Base Level 4 changes. Added PFS_getrootid(), PFS_getpathidX() , parameter descriptions. Updated structure definitions.

3 INTRODUCTION

This specification describes the PATHWORKS File System for Hydra Servers. The specification describes the functional and structural components of the file system. External data structures and prominent internal data structures are defined. The specification provides a functional definition of library interfaces such that additional libraries may be developed and added to the file system.

The specification does not describe the packaging issues or functional delivery issues. Where appropriate, considerations for these issues are noted.

4 TERMS AND SPECIFICATION SYNTAX

Throughout this document certain terms are assumed to be familiar to the reader. Knowledge of the structural components of a file system are assumed. Structural components of the VMS ODS level 2 file system, MSDOS FAT file system and Macintosh HFS file system are provided as a reference to provide context for the functions described in this specification.

The following terms are used throughout the document and are presented here to eliminate confusion which may arise due to conflicting definitions. These defintions are not intended to be absolute nor are they likely to be precise. However, this is what is meant when then following terms are used.

Attributes	General file attributes including file characteristics (hidden, directory, etc), file times (creation, modification, backup, etc), file size, parent directory, file ID, etc.
Stream	Identification of file data associated with a particular identifier. Macintosh files have two such identifiers, "data" and "resource". All other files have only one such identifier.
Fork	Synonymous with *stream* and may be used interchangeably. Most prominet use is wihtin the context of describing the Macintosh file system
Directory	Structure containing files or other directories
Folder	Synonymous with *directory* and may be used interchangeably. Most prominent use is within the context of describing the Macintosh file system.
File	Data container. This term is used to describe an addressable entity. It generally does not include directories (which are considered part of the address).
Volume	Structure containing directories and files. Represents a collection of directories and files made accessible to the *client*.
Share	Synonymous with volume in the context of NOS structures. Represents the top level directory of a set of files which are made available to *clients*.
Client	Remote operating system or user. Generally used to refer to the orginator of file system requests.
Server	Layer of software above the file system which ececutes operations on behalf of a *client*. May also be used to indicate the entire system which executes operations on behalf of the client. Where confusion may arise the two uses will be noted as *server system* or *server software*.

NOS	Network Operating Sysytem. Generally used to indicate operations or attributes associated with a supported client type, NOS security, NOS file system, NOS user, etc.
Host	System on which server software executes. Refers to characteristics of this system, host security, host file system, host user, etc.
Namespace	Identifies the semantics and syntax of a file specification. Example namepsaces are MSDOS, Macintosh, Unix, VMS, etc.
Path	A file location specification. This may be presented in one of many namespaces.
File System	Defines the semantics for the storage and retrieval of files.
Meta Data	Information about the name, location and attributes of a file.
File Service	A set of routines which define the service offered to clients of one particular type, i.e. MSDOS file service or Macintosh file service.

The following syntax is used throughout the document.

[]	Denotes optional quantities
{}n	Denotes n or more of the term enclosed in quotes

5 REFERENCES

This specification was written using the following reference material:

Inside Macintosh, Volume IV

Inside AppleTalk

VMS File System

DOS 3.1 User Guide

Guide to porting LMU

PATHWORKS for OS2 Administrator's guide

LanManager Programming Handbook

The top level interface is designed to be a super-set of the FSI interface for Microsoft's LanManager for Unix. Routine call semantics are preserved where applicable. New routines have been added to provide a complete set of functions required to support file service access requirements.

6 DESIGN REQUIREMENTS

The following list summarizes the requirements which have influenced this design. Careful consideration has been paid to insure these requirements are met. The design is tightly coupled to these requirements such that a change in requirements could have great impact on the application of the design. It is possible that a change in requirements could cause major redesign efforts.

1. All information relating to a file must be tightly coupled to that file.

   For VMS, this requirement translates into a requirement to store all applicable file meta data in application ACEs attached to the file.

2. Top level interface must support LMU server software without major redesign

   This requirement is driven by an agressive schedule and limited resources.

3. The file system must perform at par or better than existing PATHWORKS products.

   This is a loosely defined metric which needs careful evaluation. Every effort has been made to optimize access given the features of the host file system. There is a tradeoff between file system performance and file system integrity.

4. The file system must operate in a distributed fashion across a VAXCluster.

   This requirement has particular significance to the various cache designs in the file system. All file caches must be distributed. Writeable caches must have data distributed and read only caches must have consistency distributed.

5. NOS security models and host security models are completely independent.

   There will no attempt to provide NOS security in terms of host security. The various security models involved are sufficiently different such that a mapped security model would not yield suitable results.

6. NOS file attributes are completely independent.

   Attributes set from one NOS will not affect attributes of another NOS, even if there is an obvious mapping between them. Currently there are a number of such file attributes, hidden, read-only, creation time and modification time. (While both MSDOS and Macintosh specify a SYSTEM attribute it is not clear a DOS system file is also a Macintosh system file. It is not clear such a file could even be shared between NOS types.)

NOTE

A file may be readonly to one NOS and writeable to another. File modification times will not be visible between NOS types. This means that a file modified by one NOS may not be seen as modified by another.There is obvious detrimental behaviour as a result of this requirement.

However, backup times represent attributes that although common between NOS types may not be suitable for sharing. Consider a backup utility running on both a Macintosh and a PC client. If backup times were shared neither client would have a complete backup of the file set. It may or may not be adviseable to set up such a backup scenario but the results certainly would not be what was intended.

Restoration of client backups will necessarily destroy the file meta data (and potentially file data) associated with other NOS types. It is therefore not suggested that backups be done thru clients except in single NOS applications. The host backup facilities should be exclusively used in multiple NOS environments.

7. Data presented to the cache interface must be in stream format.

This requirement simplifies the data paths in the server. The file system must provide all record deblocking prior to file data being entered in the cache. This requirement PRECLUDES random access to non stream format files as there is no way to map stream offsets to record offsets. Sequential access will be allowed, however, files in non-stream format may not be read thru the data cache.

This requirement also precludes output in non-stream format of cached files as there is no mechanism to guarantee the order of writes from the cache. There is no direct mapping between stream offsets and record offsets. Record offsets can only be calculated in sequential write order. Sequential writes to non stream files will be allowed.

7 OVERVIEW

The file system interface for PATHWORKS has been abstracted to provide both NOS independence and PATHWORKS platform independence. PFS (PATHWORKS File System) provides this abstraction.

PFS provides a single interface to multiple host file systems. Functions are provided to access files, create files, delete files, rename files and provide access to information about files. Files may be accessed by the semantics of the supported client using the file syntax of the supported client. PFS provides all translation functions necessary to map the client access to a host file system access.

PFS is a superset of the Microsoft LMU FSI interface. This choice has been made due to a large body of existing code which uses this interface. While non of Microsoft's software is used, in whole or in part, in the implementation of PFS, it is necessary to credit the origin of the interface. An algorithmic view of the implementation of the LMU FSI is provided in Appendix D.

7.1 Functional overview

PFS provides functions to create files, delete files, rename files, store and retrieve file attributes and store and retrieve data associated with the file. PFS provides file access in the semantics and syntax of both MSDOS and Macintosh clients. This access includes file names, path names, data format and file attributes.

PFS operates in one of three namespaces (VMS, MSDOS or Macintosh), all of which are tightly coupled. This means there is a strict relationship between names in various namespaces. While this relationship presents obvious limitations, it allows file system functions be be significantly simplified.

PFS provides completely disjoint sets of file attributes to be associated with files.

PFS will provide functions for storing and retrieving NOS security information, provided the underlying file system is willing to accept the requests. This means that servers need to be prepared to store security data elsewhere if the underlying file system rejects the request (NET.ACC, USERMODE.LMX [is this the correct ACL file for LMX ??], etc).

PFS will provide host security checking provided that the server identifies the host user and all host user access privileges and rights. If this information is not provided PFS will allow access without regard to host security.

PFS supports all native file organizations for read access. Write access will be limited to stream format only. PFS will reject write access requests to non stream files, i.e. the file will not be opened in the hope that writes will not actually occur.

7.2 Summary of functions

The following table summarizes the functions provided by PFS.

Directory access functions

PFS_chdir	- Change default directory using PATHID structure

PFS_diridfunc	- Convert a directory ID to path name
PFS_diridinit	- Initialize directory ID handling
PFS_getcwd	- Get the current default directory
PFS_getdents	- Get directory entries in "struct dirent" format
PFS_mkdir	- Create a directory
PFS_rmdir	- Delete a directory

File access functions

PFS_close	- Close a file
PFS_copyfile	- Atomic file copy
PFS_create	- Create a file
PFS_delete	- Move file to purge area or delete it (check attributes)
PFS_open	- Open a file for read and or write access
PFS_purge	- Delete a file
PFS_rename	- Rename file
PFS_truncate	- Trucnate the file
PFS_unmap	- Clean up a memory mapped file

Datapath functions

PFS_canceldesc *	- Cancel cache descriptors
PFS_fsync	- Flush all written data associated with a file
PFS_getcachedesc *	- Obtain cache descriptors for write data
PFS_lock	- Lock a byte range in a file
PFS_lseek	- Set the current file offset for read/write functions
PFS_read	- Read data from file
PFS_readdesc *	- Read data by reference
PFS_releasedesc *	- Release data descriptors
PFS_sync	- Flush all written data associated with all files
PFS_unlock	- Unlock byte range
PFS_write	- Write data to file
PFS_writedesc *	- Write data by reference

File attributes functions

PFS_chmod	- Change file protection
PFS_chown	- Change file owner
PFS_getattr	- Get file attributes
PFS_getextattr	- Get extended attributes (not supported)
PFS_getcomment	- Get comment associated with file
PFS_filesize	- Get file size in bytes
PFS_setattr	- Set file attributes
PFS_setcomment	- Set file comment
PFS_setextattr	- Set extended attributes
PFS_stat	- Get file attributes in "struct stat" format
PFS_timefunc *	- Perform time conversion
PFS_utime	- Set file access and modification times

Path functions

PFS_dentpathid *	- Convert "struct dirent" format to pathid
PFS_didpathid *	- Translate a default directory plus NOS path into a host path
PFS_getpathid	- Translate a NOS path into a host path

PFS_fullpath	- Get translated host path
PFS_mapname	- Translate a NOS filename to a host filename (name only)
PFS_parse *	- Parse path in namespace format
PFS_pathfunc *	- Perform namespace specifc path function
PFS_shortpath	- Get translated path beyond current default directory
PFS_treetop	- Set start of NOS path in translated path

General support functions

PFS_init	- Initialize file system
PFS_geterrno *	- Get last PFS error
PFS_mpxclose	- Close host file associated with file descriptor
PFS_needfds	- UNIX only
PFS_needinodes	- UNIX only
PFS_setcontext *	- Set PFS context for thread
PFS_setlognores	- Set routine to call when resources are exhausted
PFS_setnotifympx	- Set routine to call when file multiplexing occurs
PFS_statvfs	- Obtain disk space info
PFS_fstatvfs	- Obtain disk space info

Security functions

PFS_access	- Check host access to a file
PFS_faccess *	- Check host access to an open file
PFS_getsecurity *	- Retrieve NOS security data
PFS_getsecuritymode *	- Get system security mode
PFS_getuser *	- Return PFS_USER structure for specified host user
PFS_setsecurity *	- Store NOS security data
PFS_setsecuritymode *	- Set security mode of system
PFS_setuser *	- Set global host user

7.3 File service components

A file service may be defined by four major components; namespace, attributes, security and data paths. These components allow a service to offer files stored in its native file system to a client using another file system.To implement a file service a mapping between components is necessary.

There are number of components which comprise a file system. Some of these components are more visible to a file service than others. Some file system components will define file service components while others may only have incidental effects. The following table shows how file system components are mapped to file service components.

File System Component	File Service Component
File name syntax	Namespace
Directory structure	Namespace
File allocation	Data paths
File attributes	Attributes
Security	Security
File meta data	Attributes, Security, Namespace
Quotas	Data paths

The overall effectiveness of a file service will depend on how complete the mapping between components can be defined. In general, the more robust the host file system, the more effective the file service will be.

The mapping of file service components to the VMS file system is defined in section 9.

7.3.1 Namespace

Namspace defines the file name syntax, path syntax and path semantics. A given file service may need to access files by name, by ID or possibly other mechanisms. These mechanisms need to be mapped to the supporting file system.

File name syntax varies amoung file services. Filenames range in length from 11 characters to 255 characters and consist of character sets ranging from alphanumeric to virtually unlimited. This range presents a challenge to a file service which must either be able to map names or limit the range to a more manageable set. Any limits imposed will be visible to the client

Path syntax and semantics also vary amoung file services. Path lengths may range from 1 member to virtually unlimited. File systems may impose limits on the number of members in a path and this will be visible to a client. Path semantics may be biased, relative or absolute.

Absolute path semantics specify each member of the path using a name appropriate to the file service. This name may be a character set name or an ID.

Relative path semantics specify members relative to prior members. There may be "special" names assigned to "parent" members (i.e. VMS path [-]) or parent members may be specified by the absense of a named member (i.e. Macintosh <null>).

Biased path semantics present a base path and a reative path. The base path may be a named path or an ID (i.e. VMS rooted path [member.][member] or Macintosh ID plus named path).

NOTE

> The VMS file system is among the most restrictive with respect to namepsace. The filename character set is the most restrictive as is the effective path member length. VMS does allow filenames greater in length than both MSDOS and Macintosh but this is largely negated by character set limitations.

The following table sumarizes the namespace characteristics of various clients and the VMS file system.

Table 7-1: Namespace characteristics

Characteristic	MSDOS	Macintosh	VMS
Filename length	8 with 3 ch extension	31	39 with 39 ch extension
Character set	Any greater than <space> and less than <del> with the exception of % and *	Any except <null> and :	Alphanumeric or $, _, -
Path length	Unlimited depth [Character limit ??]	Unlimited depth [Character limit ??]	8 member depth* 255 character length
Path semantics	Absolute	Absolute, biased by ID, or relative	Absolute, biased by name, or relative
Access by:	Name or 16 bit ID**	Name or 32 bit ID***	Name or 48 bit ID
File limits	[FAT limit ??]	2**32	2**24 per volume 2**32 per bound set
Directory limits	2**16	2**32	2**24

* VMS provides a mechanism to "fix" a bias (concealed logical name) such that unlimited path lengths may be accessed via 8 member relative paths. This mechanism is not supported across all applications, most notibly BACKUP. The VMS path length limit applies to applications which use RMS only as there is no limit to the depth of a path processed directly via QIO.

** MSDOS provides "fixed" directory offsets and functions may reference files via this fixed offset. This in effect becomes a 16 bit ID which may reference the file within the context of a path.

*** Macintosh assigns a 32 bit ID to each file and directory created on a volume. This number is unique and will not be reused when a file or directory is deleted. The number bears to special relationship to the file and may be swapped between files (a numeric rename function). This number is used to establish links between files declared as "alias".

PFS makes no assumptions about the mapping functions associated with a file system. The mapping of client namepsace to file system namespace is entirely defined by the file system library. PFS uses file system library functions to map client names and IDs. PFS provides interface routines to translate biased paths into absolute paths.

7.3.2 Attributes

File attributes are maintained by the file service to provide information to clients about the files to which the attributes apply. Clients have their own set of attributes which they use for various purposes as does the host file system. Mapping these attributes to file system attributes is generally not complete.

File service attributes include information about when a file was created, last modified, last accessed or backed up. File characteristics such as whether the file is a directory, visible, archived, copy protected and so on are maintained by the file service. File data formats are set when the file is created or modified and are made availabe to the file service.

The following table shows the various atributes associated with the MSDOS, Macintosh and VMS file systems.

Table 7-2: NOS File Attributes

Attribute	MSDOS	Macintosh	VMS
Create time	Modified time	Create time	Create time
Modified time	Modified time	Modified time	Revised time
Access time	Modified time	Modified time	Revised time
Backup time	N/A	Backup time	Backup time
Directory	Directory	Implied	FCH$V_DIRECTORY
Archive	Archive	N/A	N/A
Visible	Hidden	Invisible	N/A
System	System	System	N/A
Backup Needed	N/A	Backup Needed	Backup time
Rename Inhibit	N/A	Rename Inhibit	Write access to directory
Delete Inhibit	N/A	Delete Inhibit	Delete access to file
Multiple User	N/A	Multi User	N/A
Write Inhibit	Read Only	Write Inhibit	Write access to file
Copy Protect	N/A	Copy Protect	N/A
Volume ID	Volume	N/A	N/A
Finder Information	N/A	Finder Info	N/A

As can be seen from the above table, mapping client attributes to file system attributes will not provide a sufficeint mapping. It is clear some form of storage and retrieval of attributes must be provided by the underlying file system. The complex challenge to a file system is how to reflect the client attributes in terms of file system characteristics in a "least surprise" fashion.

PFS makes no assumptions about the mapping between client attributes and host file system attributes. The underlying file system may be as complete or incomplete as necessary. PFS will pass the limitations on to the server which will necessarily make the limitations visible to the client.

PFS will honor the following attributes:

Read Only	PFS will not allow writes to the file
Delete Inhibit	PFS will not allow the file to be deleted

Rename Inhibit	PFS will not allow the file to be renamed
Copy Protect	PFS will not allow the atomic copy to be used on the file. However, there is no mechanism to prevent an application from copying the file by direct open and read.
Directory	PFS will not allow direct access to the file

The remaining attributes are stored and retrieved to support server functions. It is up to the server to apply these attributes to file service functions.

7.3.3 Security

Client security models vary greatly. There is so much disparity between sercurity models that any attempted mapping would compromise all models. Given this, client security must be implemented independently of the native file system security model. However, native file system access may still be restricted by the underlying native security model. This dual model provides for client security models to be implemented at the expense of additional system management to establish the relationship between client users and host system users.

PFS provides access to secuirty data stored by servers but does not interpret the data in any way. The services are provided to associate client security data with the objects to which they apply.

PFS will pass host user identification information to the file system library. The file system library may choose to use this information as necessary. It is the responsibility of the server to establish the relationship between the client user and the host user.

All file systems are expected to keep track of which files they create on behalf of a server. It is necessary for a file system to be able to distinguish between files it has created and those which were created outside the server such that a hybrid security model may be implemented. This model will check host security only if the file was not created by the server.

PFS will pass the current security mode to the file system library. It is the responsibility of the server to determine the security mode for the path. File system libraries are expected to be capable of dealing with the following three security modes:

HOST	Check native security on all accesses
CREATOR	Check native security only if the file was not created on behalf of the server.
NOS	Ignore all native security

7.3.4 Data Paths

File services generally deal with stream file formats but there is no assumption about the data formats of the underlying file systems. For this reason there may be a conversion required between native file formats and file service formats.

PFS provides for this conversion by allowing a file system to "claim" a data path. This claim function is more restrictive than the path claim function in that the claim is applied to the path file system only. This partitioning allows PFS to obtain the path owner, get the file characteristics and then ask the file system to claim the data path give the characterisitcs. This parititoning allows file systems to claim paths without necessariliy obtaining file characterisitics (which may only be imporatant if the file is actually to be accessed).

PFS provides this function by using two dispatch vectors, the main library dispatch vector and a subset data path dispatch vector. Libraries which do not need the additional datapath claim function should leave this field defaulted which will cause PFS to dispatch thru the main vector.

All file data which passes thru the data cache must be converted to stream format. It is the responisbility of the underlying file system to supply this conversion. The file system will be supplied context infomation to support this translation. The information is maintained completly by the file system, i.e. it is in no way interpretted outside the file system.

It is possible that a file system may implement a different set of functions to deal with files of various organization and record format. These functions will be established by the FSLIB_open() function. This routine is called from PFS_open() and may return a subset data path dispath vector address in the PFS_FID structure.

NOTE

There are a number of implemenation options around datapaths. These options are briefly described below. For the purposes of this specification option 2 listed below will be assumed.

1. Implement one set of datapath functions and dispatch the appropriate routines based on record format.

   This option allows one set of vectors to be referenced and reduces the data storage required for the PFS_FID stucture. The tradeoff here is that record formats may need to be checked on every access and an additional call is placed in the data path.

2. Implement a unique set of function vectors for every combination of record formats supported.

   This option allows vectors to be referenced at the expense one copy per file format. This is most likely the best compromise as file systems which only support one file format need to do nothing special. File systems which support multiple record formats need to create one set of function vectors for each supported record format.

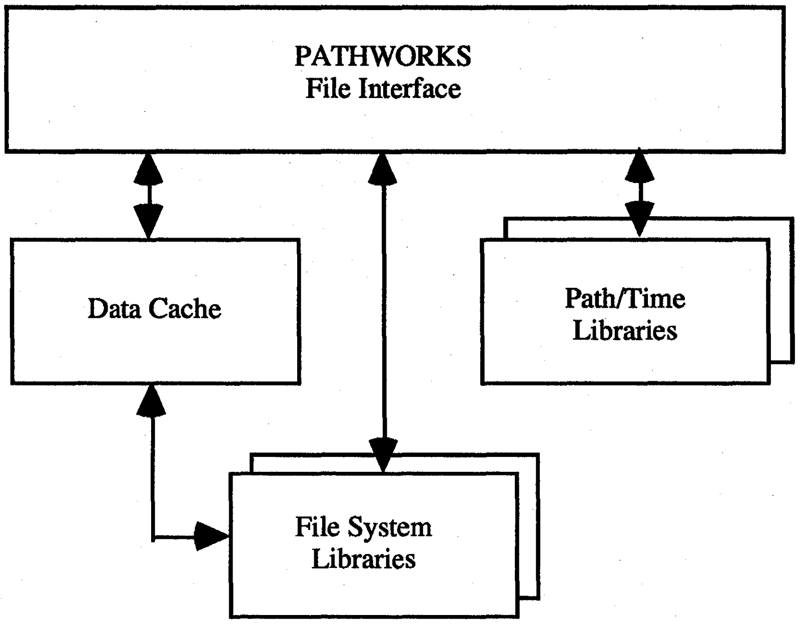
3. Copy the function vectors to the PFS_FID structure and allow the FSLIB_open() function to modify the copy.

   This option would support the most number of combinations in the simplest fashion as only a few vectors need to be modified.

7.4 Structural overview

PFS is partitioned into two major components, PATHWORKS File Interface and File System Library (FSLIB).

Figure 7-1: File System Structure Overview



7.4.1 Top level interface

The top level interface provides argument checking and dispatch functions to the appropriate FSLIB. The FSLIB is selected during PFS_getpathid() by calling each FSLIB's FSLIB_claim() routine. FSLIB_cliam() will determine if this file system owns this path and if so, will supply a set of vectors to handle all remaining FSLIB functions.

All FSLIBs are expected to handle ALL functions, even if the action is simply to return success or failure. The top level routines DO NOT check the validity of a vector prior to dispatch.

7.4.2 File System Library Interface (FSLIB)

A File System Library (FSLIB) is a collection of routines which implement the file system functions necessary to support PFS functions. There is no formal definition of file system such that a clear set of rules may be established on what is and what is not a file system. Suffce it to say that if a set of routines is prepared to handle file system functions, PFS will be prepared to use them.

An FSLIB may support "variant" file systems within it. Each variant is treated as an independent file system and only shares the FSLIB_init routine with its other variants. This mechanism allows multiple collections of routines to be grouped within a file system library. It should be stressed that each variant is treated separately and must be capable of identifying the paths on which it will operate without regard to its other variants.

The FSLIB functions are roughly parallel to the PFS functions, i.e. PFS does very little except find the appropriate FSLIB for a given path and dispatch FSLIB functions to handle PFS functions.

PFS requires that a given path resolve to at least one FSLIB. There is no implied hierarchy in a set of FSLIBs nor may any one library expect it being asked to handle a path given anopther has rejected the path. Each FSLIB must be capable of identifying paths which belong to it, independent of decisions made by another FSLIB. This is crucial given there is no implied order in sequencing path ownership functions.

7.4.2.1 FSLIB Path Claim

Each path on which PFS must operate must be claimed by at least one file system. There is a possibility that multiple file systems may handle a given path and if so, the first to claim it will be given the opportunity to service it. Once a path is claimed the FSLIB will be responsible for handling all subsequent operations on that path.

The FSLIB is given a "pseudo" file system path defining the "root" of the path. In most cases this path is sufficient to determine ownership. Path ownership may be a function of volume ACP or it may be a function of path component format (i.e. container files). The format of the "pseudo" path is given below.

```
device:{[directory_spec{.@container_file}]}
```

where device is a physical device name, directory_spec is a VMS hierarchial directory spec (of the form [directory{.directory}]) and @container_file is the name of a foreign file system container file.

NOTE

> Foreign container files are currently limited to support of MSDOS FAT file system. However it is concievable that additional foreign file system container files nay be added. If this is the case additional work will be required to identify them without resorting to opening the file and scanning the format.

The FSLIB is also given the client path and client namespace identifier. This information may be used to select a variant file system within an FSLIB.

7.4.2.2 FSLIB Initialization

Each FSLIB is called at its initialization entry point during PFS initialization. The library should set up all data structures required to handle subsequent function requests. This routine will be called only once at system startup time.

The FSLIB is required to initialize a PFS_LIB_ENT structure at this time. The structure contains the name of the FSLIB, its characteristics and its function dispatch vectors.

PFS will locate the initialization routine by UNIVERSAL SYMBOL name. This routine must be globally defined in the library and MUST be of the form XXX_init, where XXX is the name of the FSLIB. This is the ONLY symbol in the FSLIB which is referenced by name. All other functions will be referenced by entries in the function dispatch vector.

The initialization routine will be called multiple times allowing the library to establish variant function dispatch vectors.This feature allows libraries to implement separate functions for handling various client anomolies if necessary. A library is not required to handle various clients in any particular fashion and variants are strictly optional.

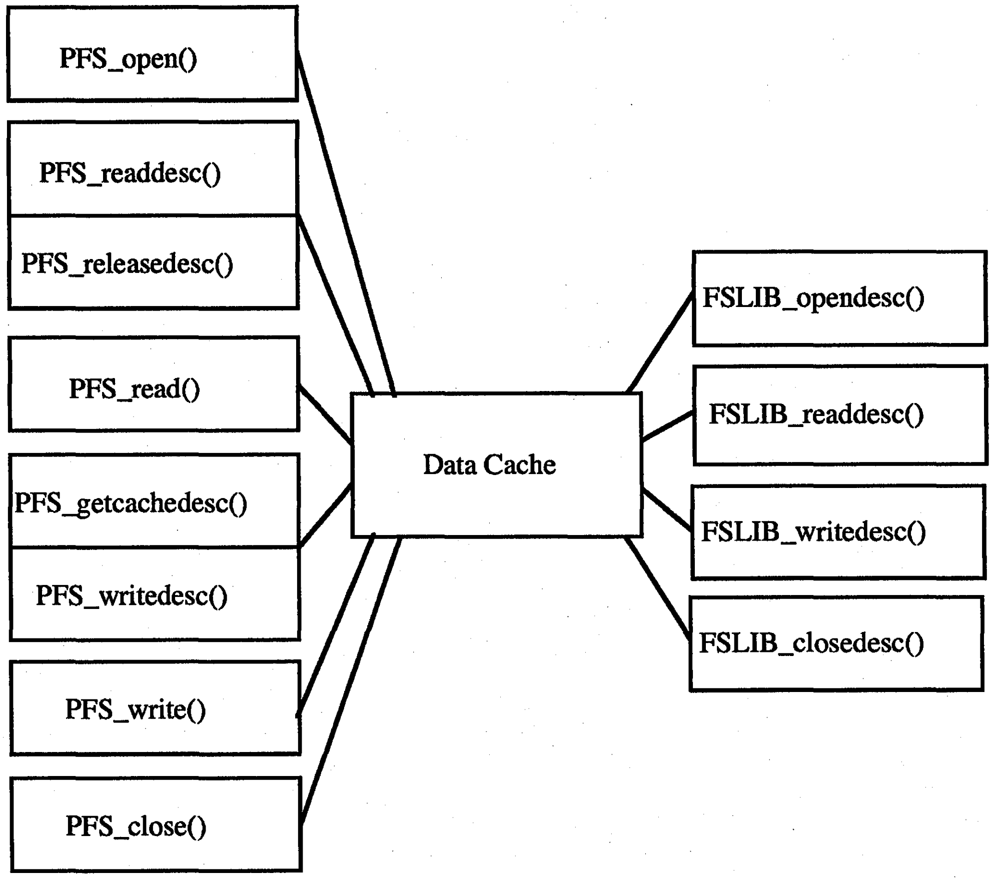
7.4.3 Data cache interface

PFS vectors all file read and write requests thru the data cache with the exception of atomic file copy operations. The data cache is given a set of read and write file functions which it will use to fill the cache and perform writebacks.

The file read and write functions are established when the path in which the file resides is claimed. These functions are given to the data cache manager when the file is opened. It is important to note that file structure will affect the read and write functions and this information must be known when the path is claimed.

The interface to the cache is strictly read by reference. A list of data buffer descriptors is passed between data cache requests as well as being passed to file read and write functions. PFS will make these descriptors lists available to servers theu PFS_readdesc and PFS_writedesc functions.

Figure 7-2: PFS, Data Cache and File System Library Interfaces



The PFS file access routines and their interaction with data cache functions are briefly described below:

PFS_open	This function must be issued prior to any cache access. The function will establish a data cache "handle" for use by cache access routines. The handle is stored internally and is referenced by the open file PFS_FID structure.
PFS_read	Read bytes of data and copy the result to the caller's buffer. The function uses the data cache intrface internally.
PFS_write	Write bytes of data from the caller's buffer. The function uses the data cache interface internally.
PFS_readesc	Read bytes of data and return a buffer descriptor pointing to data cache blocks containing the requested data. This is a direct interface to the data cache. No data is actually transferred. The data cache blocks are "locked down" to prevent reuse while the descriptor holder is processing the data.

PFS_releasedesc	Release a set of cache buffers pointed to by descriptor.
PFS_getcachedesc	Obtain a buffer descriptor pointing to data cache blocks. This function is used prior to obtaining client write data, thereby filling the data cache directly. Data bytes prior to the first byte of the write range will be read from the file. Data bytes after the last byte of the write range will also be read from the file (if not after EOF). The most efficient use of the cache is to always write full cache blocks on cache block boundaries as this will eliminate the need to fill buffers. The cache buffers are "locked down" until a write function or a release function is issued.
PFS_writedesc	Release written cache blocks pointed to by descriptor or (less efficient) copy bytes from a set of general buffers to the data cache. Servers should always preallocate cache buffers by using PFS_getcachedesc() where possible. This eliminates the need to obtain buffers during the write function and also eliminates the need to copy data.
PFS_canceldesc	Release descriptors obtained for write with no modification. This function is used to back out of a write sequence when errors are detected.
PFS_close	Release the cache file handle. All buffers must be flushed prior to close or as part of the function.

Descriptor read sequences are as folllows:

```
PFS_readdesc(fp, size, offset, desc);     /* Obtain a set of buffers containng
                                             data and lock down in cache */
...                                       /* Process buffer */
PFS_releasedesc(fp, desc);                /* Release the set of buffers */
```

Descriptor write sequences are as follows:

```
PFS_getcachedesc(fp, size, offset, decs); /* Obtain a set of buffers containing
                                             valid data outside the write range */
....                                      /* Fill the write range */
PFS_writedesc(fp, offset, desc);          /* Mark the buffers valid and release
                                             them */
```

or:

```
PFS_getcachedesc(fp, size, offset, decs); /* Obtain a set of buffers containing
                                             valid data outside the write range */
....                                      /* Fill the write range */
PFS_canceldesc(fp, offset, desc);         /* Cancel the write */
```

7.5 Data structures

PFS defines a number of data structures which are used to pass information between PFS and servers. These structures maintain "cached" information to eliminate redundant file system functions. This mechanism needs careful review when applied to a distributed file system. Certainly the possibility exists that this information could change without the accessor's knowledge resulting in use of stale data. In many cases this does not present a significant problem as there is sufficient ambiguity in the order of operations in a distributed file system. There is no interlock mechanism for modification of file meta data. To eliminate possible read-modify-write scenarios all data structres which hold modified data also hold a mask indicating which data is modified. This mask may be used by file system libraries to limit writeback modifications. PFS itself does not use the contents of these structures. Rather it passes all requests for information contained in these structures to the file system library. The file system library needs to provide the mechanisms to guarantee the contents are current.

The following section define the data structures which are seen outside of PFS. Many if the fields of these data structures are not intended for direct use by servers. Many fields are file system specific and will vary in format and/or content between file systems. These fields are noted in the following descriptions.

7.5.1 PFS_PATHID

The PFS_PATHID structure is used to hold mapped path information. This structure is returned by PFS_getpathid() and is used as a file specification for all PFS access functions. Servers must obtain a PFS_PATHID structure for a given path prior to any file service functions which are expected to deal with this path.

The server may modify the security_mode field of the PFS_PATHID structure to effect "per root" host security models.

Figure 7-3: Format of the PFS_PATHID structure

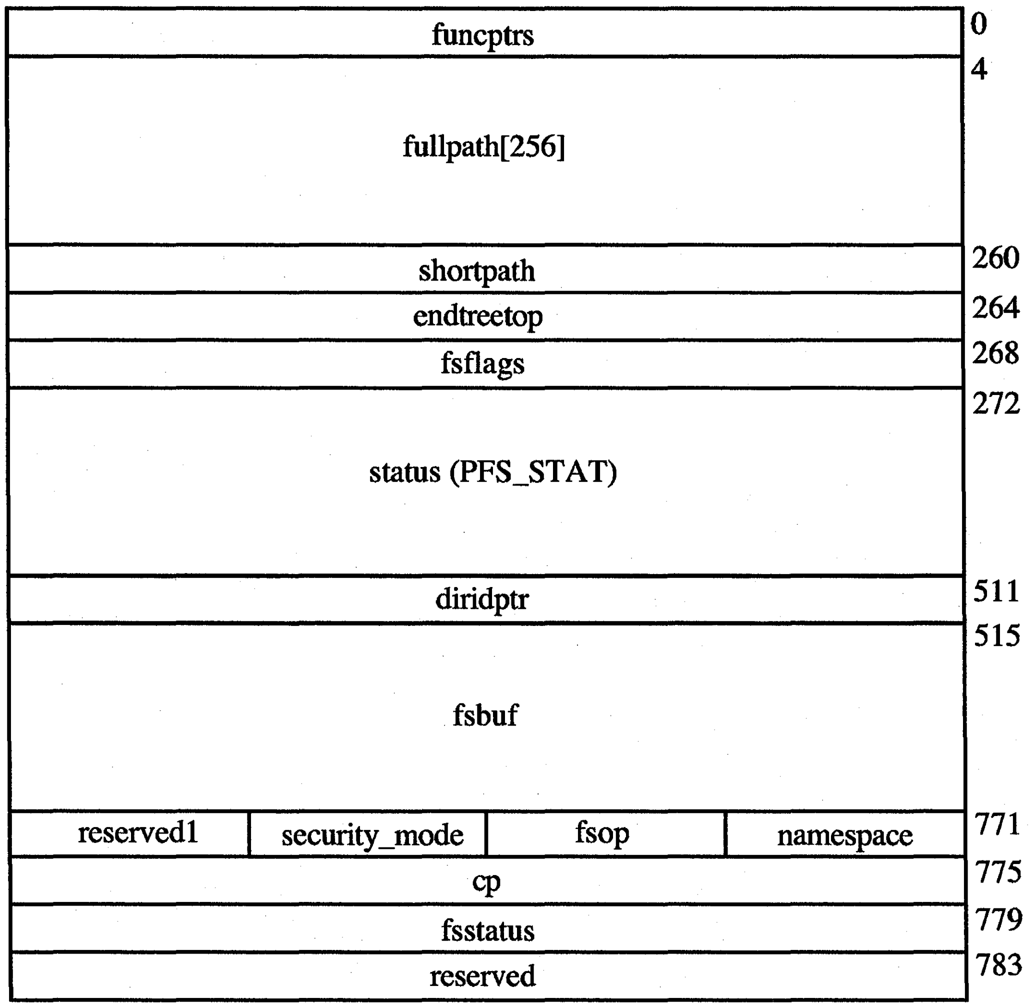


Table 7-3: Contents of the PFS_PATHID structure

Field Name	Description
funcptrs	Pointer to the file system library dispatch vector in the PFS_LIB_ENT structure for the file system. This pointer is used to locate all file system functions.
fullpath	Resolved native file specification. This buffer holds the name of the host file or path which maps to the specified client path.
shortpath	Pointer to the start of the fullpath which needs further resolution. This filed is not currently used or suported by PFS. This field is used to optimize Unix access functions.
endtreetop	Pointer to the start of the fullpath which maps to client path, i.e. the point beyond the share directory or volume directory. PFS does not use this field. It is present for server use only. It is not suggested that new server software use this field.
fsflags	Pointer to file system characteristic flags in the PFS_LIB_ENT structure. This pointer is used by PFS to determine if a file system supports various features.
status	PFS_STAT structure holding file characteristics, location information and various other file system specific information. The information in this structure is known to and used by PFS. It is maintained by the file system library.
diridptr	Pointer to next directory ID to be assigned on directory creates. This field is not used by PFS and is not supported. This field represents a shared partitioning of assignment of directory IDs between the file system and the server. This partiton does not exist between PFS and associated servers.
fsbuf	This is a holding buffer for file system lihrary mapping functions. This buffer is used to pass information between PFS and file system libraries.
namespace	Identifies the namepsace in which this path is operating.

Table 7-3 (cont): Contents of the PFS_PATHID structure

fsop	File system operation when error occured. This field may be logged by servers but should not be used otherwise.
security_mode	Path security mode. Servers may set this after issuing a PFS_getpathid() function to set a share specific security mode. PFS always initializes this field to the global security mode, established by PFS_setsecuritymode().
cp	Claim parameter. FSLIB_claim functions are allowed to return a longword parameter. This parameter is stored here and is made accessible to file system library functions thru this offset. No assumptions are made about the contents of this longword.
fsstatus	File system error status. This field is file system specifiec and may be logged by servers. This field should not be used otherwise.

7.5.2 PFS_FID

The PFS_FID structure represents an open file. This structure is returned by PFS_open() and PFS_create(). This file identifier is necessary for all data path operations in PFS and is used for some of the file attributes functions as well. Any file opened by PFS will have an associated PFS_FID structure.

Figure 7-4: Format of the PFS_FID structure

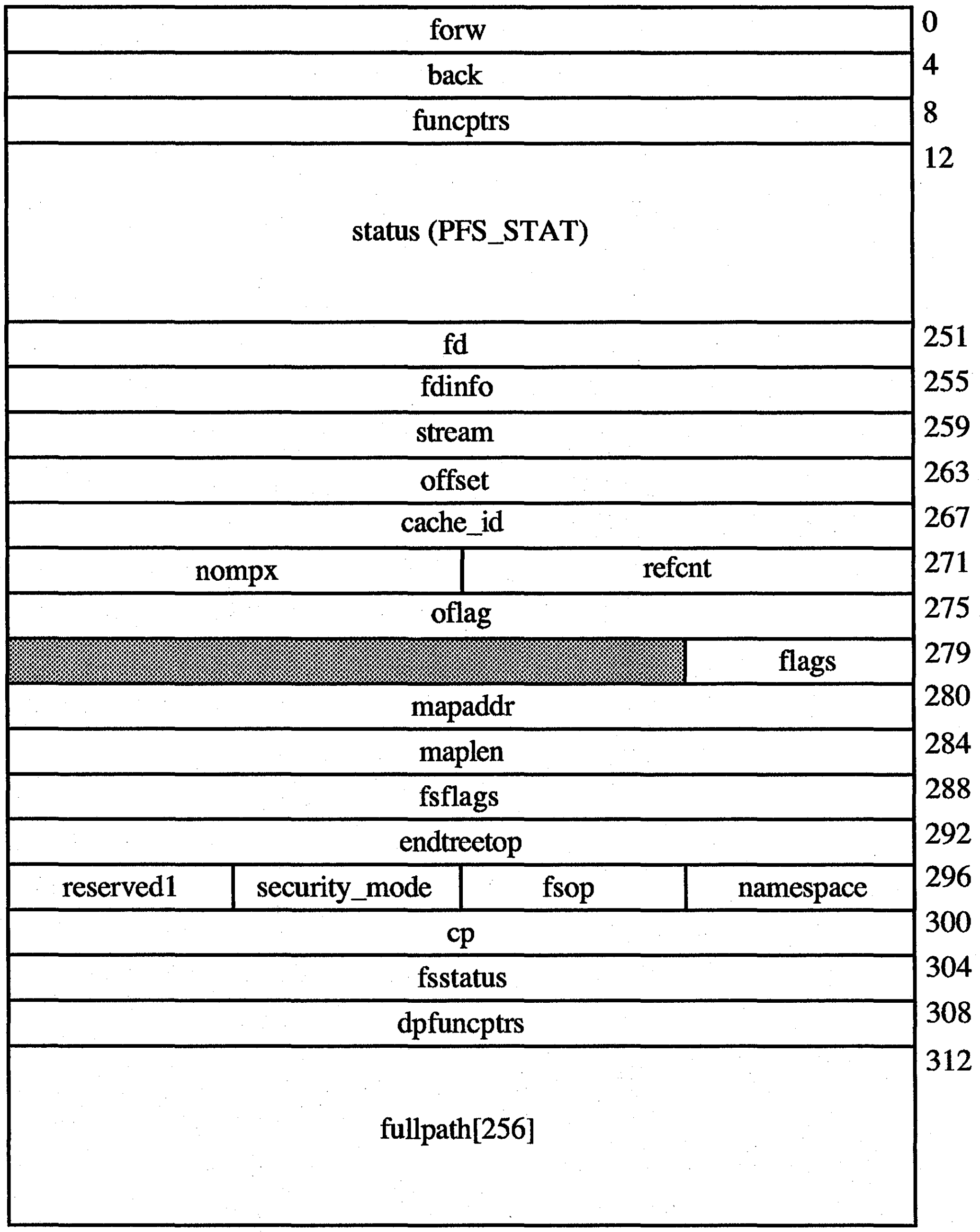


Table 7-4: Contents of the PFS_FID structure

Field Name	Description
forw	Forward link pointer. This field is not currently used by PFS.
back	Back link pointer. This field is not currently used by PFS.
funcptrs	Pointer to file system library dispatch vector. This pointer may be a pointer to the PFS_LIB_ENT vector or may be a specific vector based on file format.
status	PFS_STAT structure containing information about the file.
fd	Open file descriptor. This longword is reserved for use by file system libraries. The contents of this longword are not interpretted by PFS.
fdinfo	Information about the open file descriptor. This longword is reserved for use by file system libraries as they deem necessary. No assumptions are made about its contents by PFS.
stream	Data stream identifier. May be PFS_PRIMARY or PFS_RESOURCE representing the data or resource streams of a file.
offset	Current stream offset in file.
cache_id	32 bit cache handle associated with the file. This handle must be used for all cache references.
refcnt	Number of servers which are referencing this shared file.
nompx	Counter to inhibit multiplex closing of this file. This field is not used by PFS.
oflag	Copy of open mode passed to PFS_open() or PFS_create(). This field is used to support file multiplexing and as such is not used by PFS.
flags.mandlock	File has manditory locking set.
flags.dirty	File has been modified.
mapaddr	File memory map address. This feature is not supported by PFS.
maplen	Length of memory map. See above.
fsflags	Pointer to file system library flags in PFS_LIB_ENT structure for the file system which claimed this file.
endtreetop	This field is not used by PFS.
namespace	Namespace in which this file was opened.
fsop	File system operation when error occurred. This field may be logged by servers but should not be used otherwise.

Table 7-4 (cont): Contents of the PFS_FID structure

Field Name	Description
security_mode	Path security mode. This field is copied from the pathid structure when the file is opened or created.
cp	Claim parameter. This parameter is copied from the associated PFS_PATHID structure and is made available to file system libraries thru this offset.
fsstatus	File system function status. This field may be logged by servers but should not be used otherwise.
dpfuncptrs	Datapath dispatch vectors. This vecor is a subset of the main library dispatch vector and is used to handle file system specific data path functions. If this field is zero, datapath functions will be dispatched thru the main vector. If this vector is specified, it completely overrides the main dispatch vector for datapath functions, i.e. there is no hierarchy implied or partial replacement of functions.
fullpath	Copy of the PFS_PATHID fullpath buffer.

7.5.3 PFS_ATTR

The PFS_ATTR structure is used to store and retrieve file service attributes. The attributes structure has a mask associated with it which specifies which fields are to be read and written. This "bit set" model solves the problem of shared file access with "cached" data in the structure.

This structure has been modified to better support multiple file systems and platform independence. Additional fields have been added to represent attributes associated with supported clients. Where possible the structure has been modified in an upward compatible manner. Time field format changes are inevitably not upward compatible.

Figure 7-5: Format of the PFS_ATTR structure

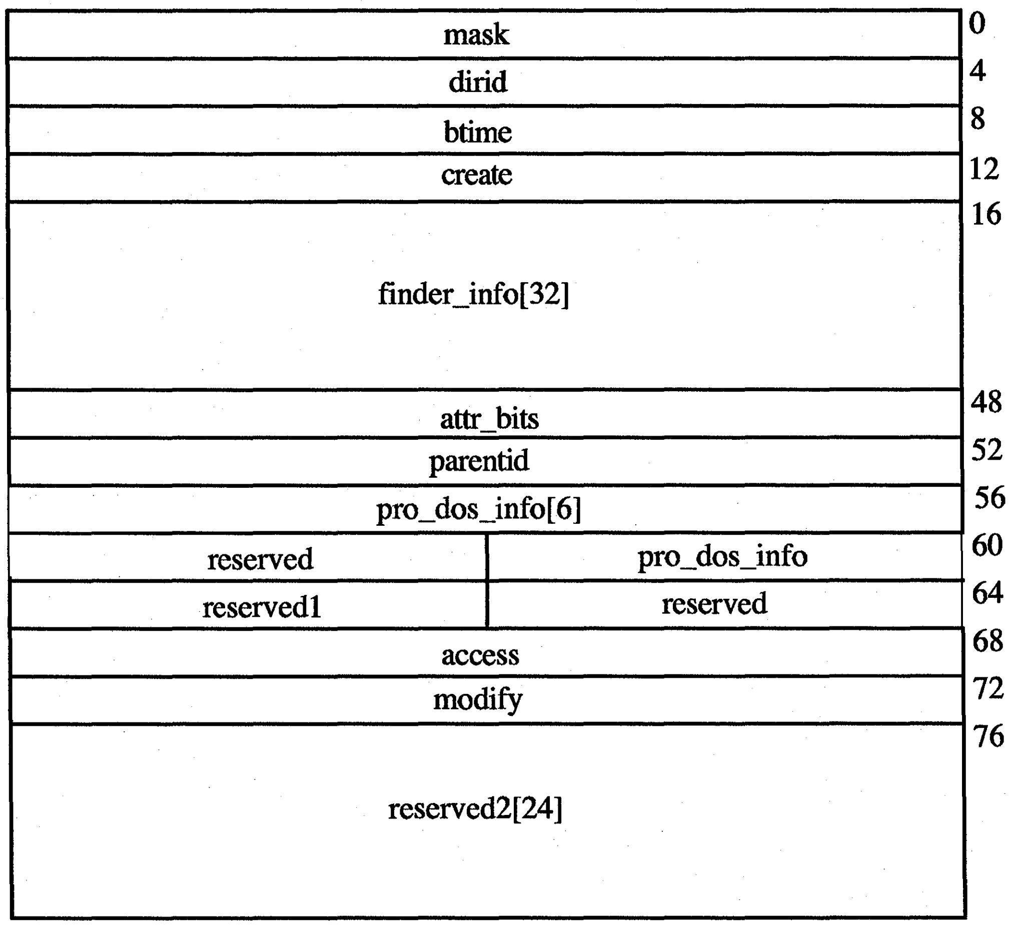


Table 7-5: Contents of the PFS_ATTR structure

Field Name	Description
mask	Bit mask indicating the validity of each field in the structure. This mask specifies which fields are to be modified on a get operation and which fields are to be written on a set function.

Table 7-5 (cont): Contents of the PFS_ATTR structure

Field Name	Description
dirid	Directory ID associated with a directory path or file ID when associated with a file path. This field carries the 32 bit Macintosh directory or file ID. This field may or may not have significance for other file services.
btime	Backup time in namespace specific format, i.e. DOS, MAC
create	Create time in namespace specific format.
finder_info	32 bytes of information associated with the Macintosh Finder. This filed has no meaning for non Macintosh clients.
attr_bits.archive	File has been archived.
attr_bits.hidden	File is not visible to directory list operations.
attr_bits.issystem	File is a system file.
attr_bits.no_rename	File can not be renamed. See PFS_rename().
attr_bits.no_delete	File can not be deleted. See PFS_delete().
attr_bits.no_copy	File can be copied with atomic copy function. See PFS_copyfile().
attr_bits.read_only	File can not be written. See PFS_open().
attr_bits.mac_appl	File is a Macintosh application.
attr_bits.multi_user	File can be open by multiple readers. This bit only has significance if the mac_appl bit is also set.
attr_bits.no_purge	File can not be purged. See PFS_purge().
attr_bits.exec_only	File can only be open for execute access. It is not clear how this bit can be honoured but it is here just in case.
attr_bits.nw_indexed	Netware index file. This bit is always 0.
attr_bits.nw_transact	Netware transaction tracking enabled.
attr_bits.nw_rd_audit	Netware read auditing enabled
attr_bits.nw_wr_audit	Netware write audit enabled.
attr_bits.nw_reserved	Reserved bits for Netware.
attr_bits.backup_needed	File needs to be backed up. This is a client specific field, i.e. it has not relationship to VMS backup attributes of a file.
parentid	Parent directory ID. This field caries the 32 bit Macintosh file ID. It may or may not be applicable to other file services.
pro_dos_info	Macintosh specific data.
access	File access time in Unix format.
modify	File modification time in Unix format.

7.5.4 PFS_STAT

This structure is a collection of Unix file attributes and has very little application to non Unix systems. It is highly questionable whther this information should be exported to servers. However, there is application within the file system. Location information may be saved such that additional file access may be eliminated when multiple references are made to a file.

NOTE

This structure has been modified to support the VMS ODS-2 file system. This is clearly a file system issue and should be defined elsewhere. It is likely more appropriate to keep this information in an opaque data structure managed by the file system library. To do so would require a maximum size be established for the structure such that PFS may continue to manage the allocation of the structres which contain this structure. This issue may be addressed in future developments of PFS.

Figure 7-6: Format of the PFS_STAT structure

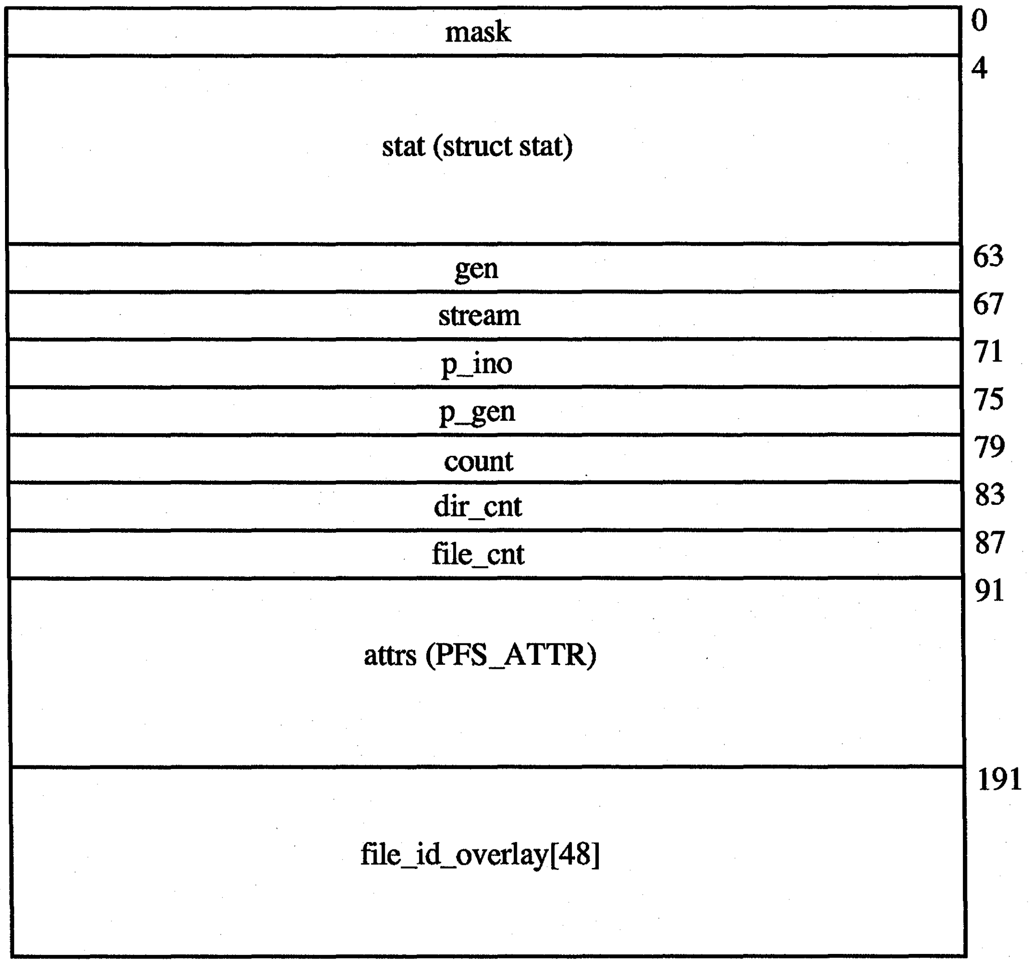


Table 7-6: Contents of the PFS_STAT structure

Field Name	Description
mask	Mask indicating the validity of members of this structure
stat	Contains a "struct stat" structure defining various low level file attributes.
gen	File generation number. This field is maintained by the file system library and may or may not be supported.
stream	Data stream associated with this file. This field may have significance in file systems which implement serparate files for each data stream supported. This field is maintained by the file system library and may or may not be supported.
p_ino	Parent INODE. This is a Unix concept and is only supported by Unix file system libraries.
p_gen	Parent generation number. This field is maintained by the file system library and may or may not be supported.
count	Number of files contained in a directory. This field is intended for export to server to support the Macintosh offspring count. This field is not supported for non Unix based file systems.
dir_cnt	Directory offspring. This field is not supported for non Unix based file systems.
file_cnt	File count. This field is not supported for non Unix based file systems.
attr	PFS_ATTR structure.
file_id_overlay	48 byte file identification buffer. This buffer is file system specific.

As can be seen from the above descriptions, this structure is of little value outside PFS with the exception of the PFS_ATTR structure. The structure should be redefined to attempt to merge members which are relavent to a particular file system. This may be done in future developments of PFS.

7.5.5 PFS_NAMEID

The PFS_NAMEID structure is used by PFS_parse() to store information about components of a pathname. The structure has fields defined for components of various namespaces. This structure only deals with named paths and does not carry any translation information. It is used to provide common server parse function support.

Figure 7-7: Format of the PFS_NAMEID structure

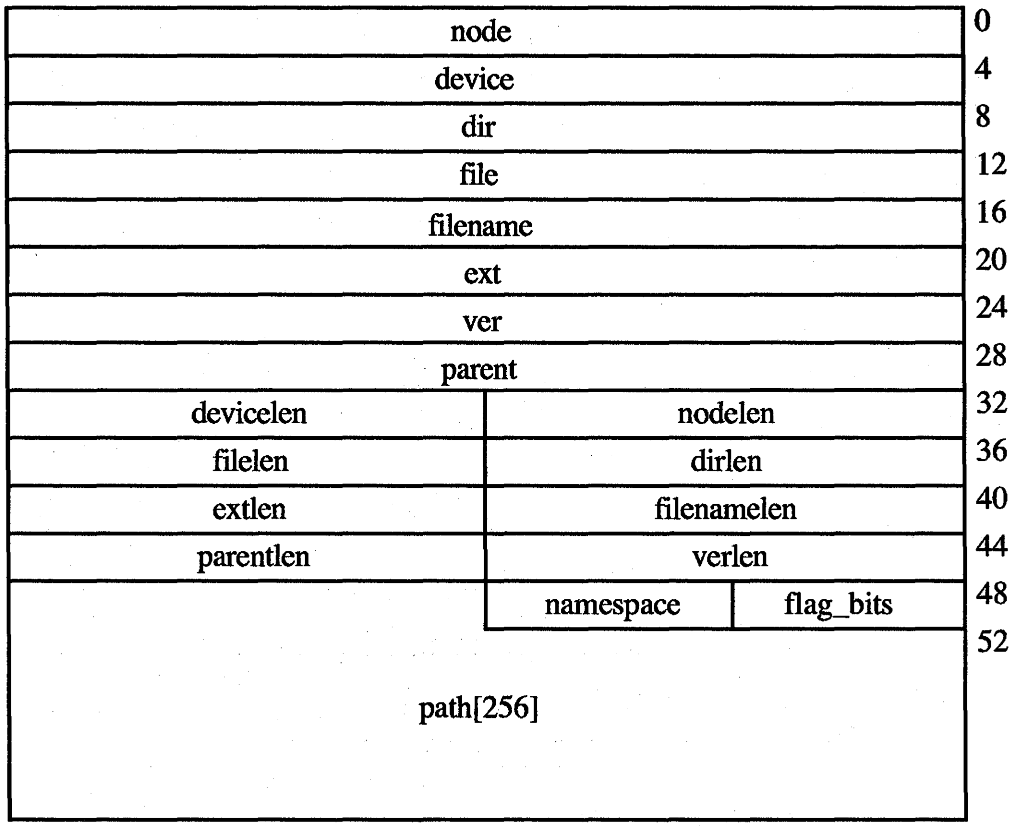


Table 7-7: Contents of the PFS_NAMEID structure

Field Name	Description
node	Pointer to the node name in the path buffer. If the node name is not present or if the namespace does not support node names, this field will be NULL.
device	Pointer to device name in path buffer. If no device is present or if the namespace does not support device names the field will be NULL.
dir	Pointer to start of directory component. This will generally be the start of the path for namespaces which do not support devices. The pointer includes the leading directory delimiter.

Table 7-7 (cont): Contents of the PFS_NAMEID structure

Field Name	Description
file	Pointer to the start of the file specification.
filename	Pointer to start of filename component.
ext	Pointer to start of extension component. The pointer includes the leading extension deliminter.
ver	Pointer to the file version number.
parent	This field is obsolete. Use the PFS_pathfunc() function to extract the parent specification.
nodelen	Length of the name name string. This length includes the trailing node delimiter.
devicelen	Length of the device string. The length includes the trailing device delimiter.
dirlen	Length of the dirctory string. The length includes the trailing directory delimiter.
filelen	Length of the whole file specification, including extension and version.
filenamelen	Length of the filename string.
extlen	Length of the extension string.
verlen	Length of the version number.
parentlen	This field is obsolete. Use the PFS_pathfunc() function to extract the parent specification.
flag_bits.isdir	This bit will be set if the path is specified as a directory path. This bit does not indicate the path actually exists as a directory.
flag_bits.iswild	This bit will be set if any wildcard characters appear in the path.
flag_bits.iswildfile	This bit will be set if any wildcard characters appear in the file specification (filename, extension or version).
flag_bits.iswildpath	This bit will be set if any wildcard characters appear in the path specification (node, device or directory).
namespace	Namespace in which path was parsed.
path	Buffer containing the full path string. This buffer is included in the structure such that the structure may be passed without requiring translation of pointers.

7.5.6 PFS_CWD

The PFS_CWD structure holds the data associated with the current working directory.

Figure 7-8: Format of the PFS_CWD structure

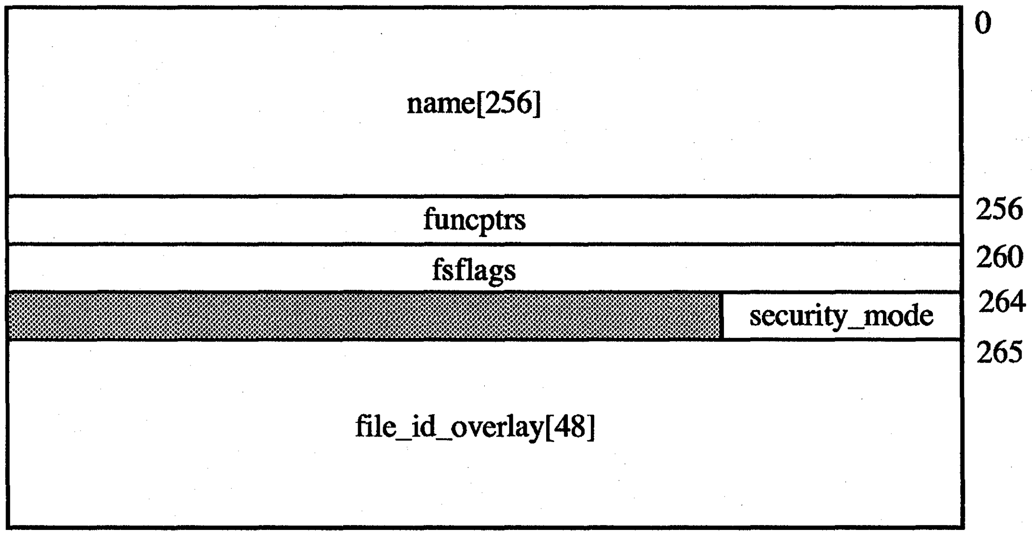


Table 7-8: Contents of the PFS_CWD structure

Field Name	Description
name	Buffer containing the full path string.
funcptrs	Function pointers for file system in which default exists.
fsflags	Pointer to file system flags in the PFS_LIB_ENT structure for the file system which claimed the default.
security_mode	Path security mode.
file_id_overlay	48 byte file identification buffer. The format of this buffer is file system specific.

7.5.7 PFS_USER

The PFS_USER structure holds the host user identification, privileges and rights for the mapped host user. This structure is used to represent the client for various security related functions.

The PFS_USER structure contains a pointer to an array of host user rights. The rights are stored in the PFS_RIGHTS structure.

Figure 7-9: Format of the PFS_RIGHTS structure

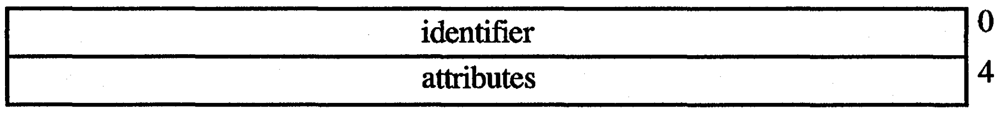


Table 7-9: Contents of the PFS_RIGHTS structure

Field Name	Description
identifier	32 bit rights identifier.
attrributes	Rights attributes. This field is not used by PFS directly.

The PFS_USER structure is obtained via PFS_getuser(). It is the server's responsibility to map clients to host users and obtain this structure. The PFS_USER structure is presented to all file system functions which check access or host user quotas.

The host user name and host user account are returned in this structure for various accounting funtions.

Figure 7-10: Format of the PFS_USER structure

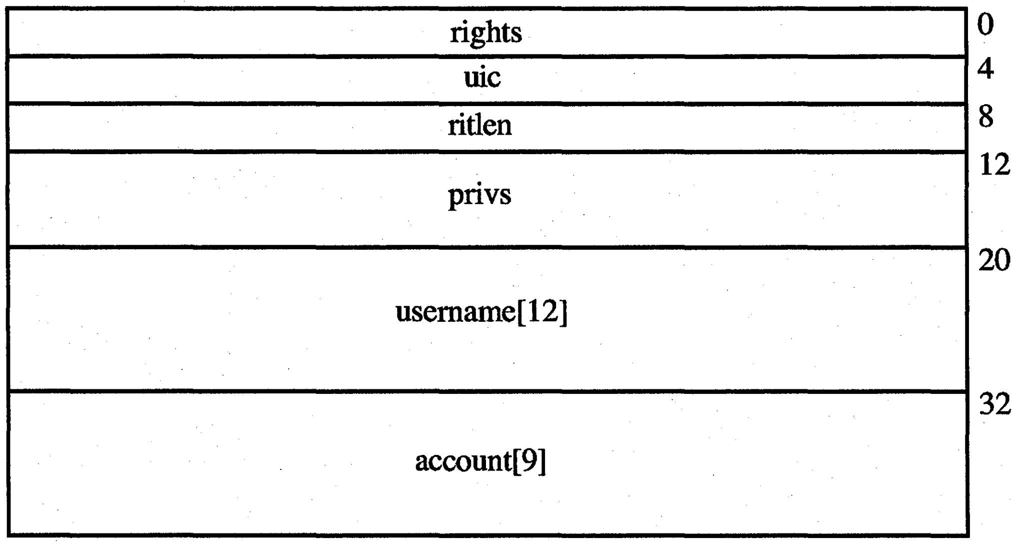


Table 7-10: Contents of the PFS_USER structure

Field Name	Description
rights	Pointer to rights list. This list is an array of PFS_RIGHTS structures.
uic	Host user identification in uid_t format.
ritlen	Length of rights list
privs	Quadword privilege mask.
username	Blank padded host username.
account	Blank padded host account.

7.5.8 PFS_LIB_ENT

The PFS_LIB_ENT structure defines the name and capabilities of a file system library. The library's function dispatch vectors are passed in this structure. This vector provides the interface to the file system library. The structure is initialized by the file system when the FSLIB_init function is called (the only external function interface to a file system library).

Figure 7-11: Format of the PFS_LIB_ENT structure

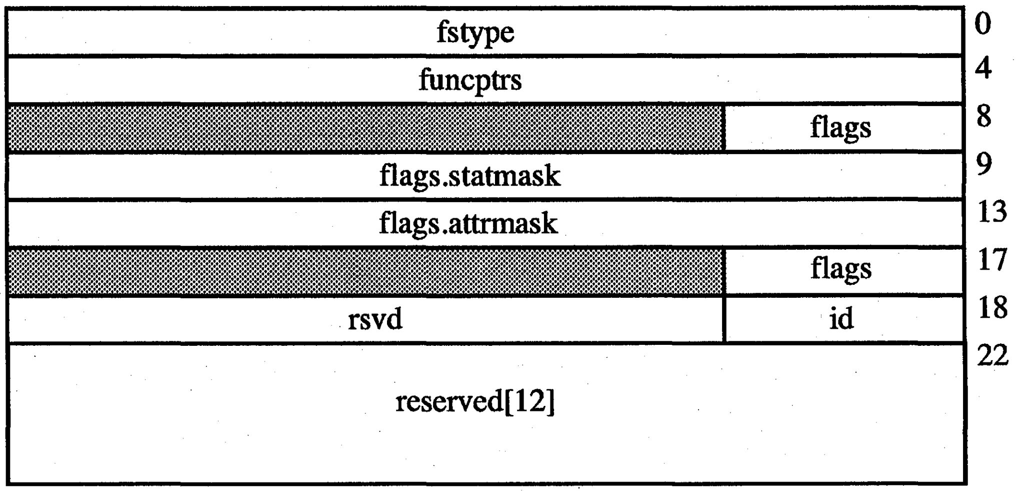


Table 7-11: Contents of the PFS_LIB_ENT structure

Field Name	Description
fstype	Pointer to the name of the library.
funcptrs	Pointer to library dispatch vectors.
flags.unixfs	Indicates unix file system.
flags.resource	File system support resource forks.
flags.extattrs	File system support extended attributes.
flags.cscreate	File system supports case sensitive file names.
flags.mappedfs	File system is mapped to another file system.
flags.statmask	PFS_STAT elements supported.
flags.attrmask	PFS_ATTR elements supported.
flags.security	File system supports security data.
flags.read_only	File system is read only.
flags.mapdirs	Directory paths are not compatible with file paths and need to be mapped.
flags.propsec	File system can propagate NOS security data on new directory creates.
id	File system identifier supplied by PFS after calling FSLIB_init. This identifer must be used by the file system library to build unique device identifiers.

7.5.9 PFS_IDENT

The PFS_IDENT structure holds the data associated with a print file. While this information is presented in VMS format it is expected that this structure will be modified to suit other platforms.

Figure 7-12: Format of the PFS_IDENT structure

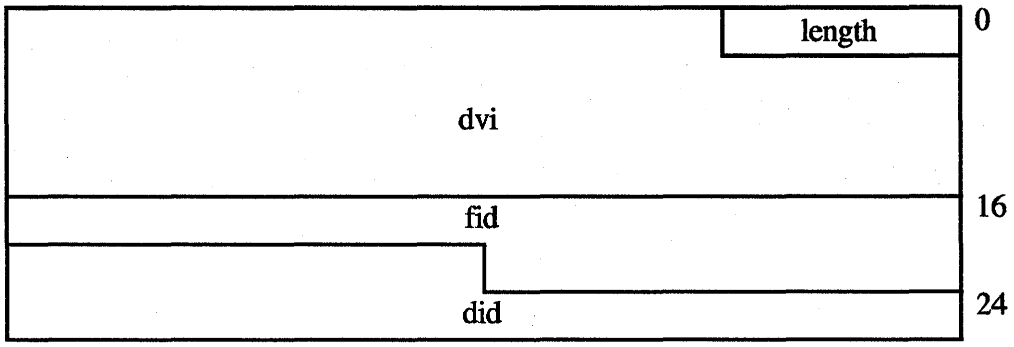


Table 7-12: Contents of the PFS_IDENT structure

Field Name	Description
length	Length of device name. Limit of 15 bytes.
dvi	Device name string. This string is not counted and is limited to 15 bytes.
fid	6 byte file identification.
did	6 byte directory identification.

7.5.10 PFS_ROOTID

The PFS_ROOTID structure is used to hold a translated root specification. This specification is used as the path bias for all client path translations. This corresponds to the LanManager "share" or Macintosh "volume". This structure is initialized by the PFS_getrootid() function and may be used as the root specification for PFS_getpathidX(). This mechanism optimizes file systems which may claim any path based on the root specification.

Figure 7-13: Format of the PFS_ROOTID structure

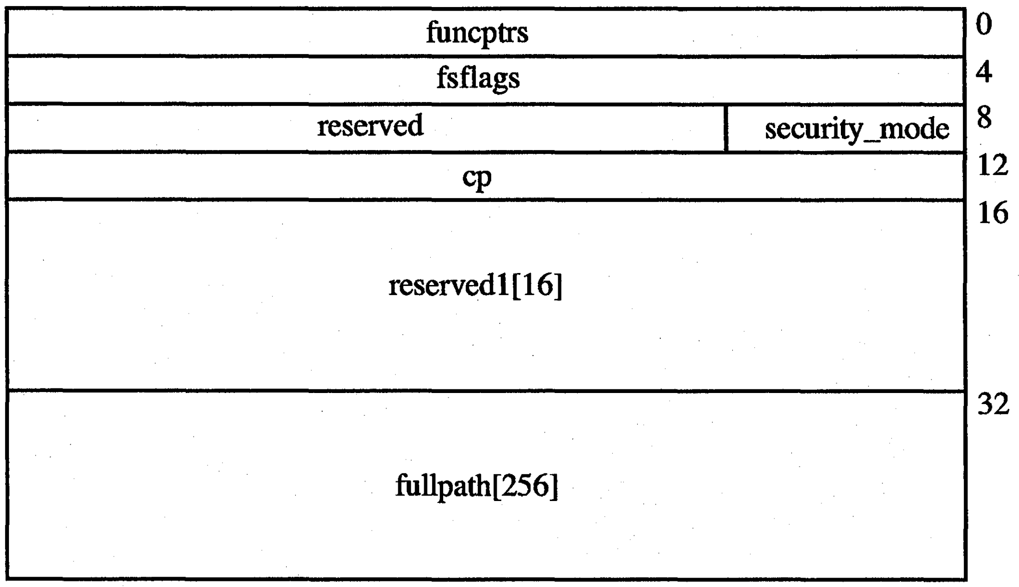


Table 7-13: Contents of the PFS_ROOTID structure

Field Name	Description
funcptrs	File system library function pointers.
fsflags	Pointer to file system library flags.
security_mode	Root security mode. This field may be modified by the server to effect root specific security models.
cp	File system claim parameter.
fullpath	Full translated root specification

7.5.11 PFS_EAOPS

The PFS_EAOPS (Extended Attribute Operations) structure is used to specify a set of OS/2 extended attributes or LanManager security data records. There are five structures used in the PFS_EAOPS interface. The PFS_EAOPS structure is the top level structure. It contains pointers to two structures, the PFS_GEALIST (Get Extended Attributes List) structure and the PFS_FEALIST Found Extended Attributes List) structure. The PFS_GEALIST structure contains a pointer to an array of PFS_GEA (Get Extended Attributes) elements. The PFS_FEALIST structure contains a pointer a buffer which contains an array of PFS_FEA (Found Extended Attributes) elements as well as additional space for returned attributes. The arrangement of structures is shown in the description of PFS_getextattr().

Figure 7-14: Format of the PFS_EAOPS structure

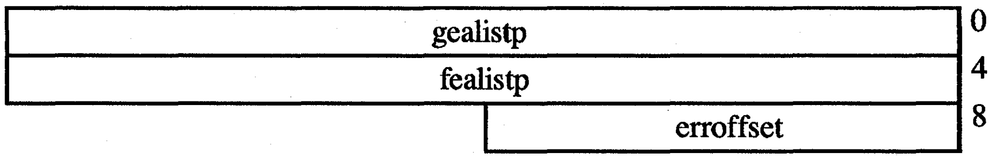


Table 7-14: Contents of the PFS_EAOPS structure

Field Name	Description
gealistp	Pointer to the PFS_GEALIST structure.
fealistp	Pointer to the PFS_FEALIST structure.
erroffset	If an errors in a PFS_EAOPS function, this field will point to the last successfully processed entry. The PFS_GEA index and PFS_FEA index are always the same.

The PFS_FEA structure contains the return attributes. The first region of the PFS_FEALIST list buffer contains an array of PFS_FEA elements. The elements are arranged in the same order as the PFS_GEA array when named attributes are requested. If all attributes are requested, the arrangement of attributes in the PFS_FEALIST list buffer will be the order in which they are found on the file. This order is not predictable and may change when attributes are added, modified or deleted.

Each PFS_FEA element contains two pointers into the data region of the PFS_FEALIST list buffer, one for the attribute name and the other for the attribute value. Names and values are arbitrary binary strings and are located with a simple binary comparison. The length of each string is returned in the PFS_FEA element.

Figure 7-15: Format of the PFS_FEA structure

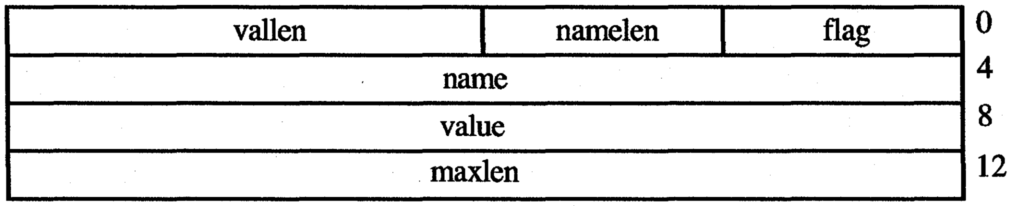


Table 7-15: Contents of the PFS_FEA structure

Field Name	Description
flag	Attribute flags. This field is not currently used.
namelen	Length of the return attribute name.
vallen	Length of the return attribute value.
name	Pointer to the attribute name buffer.
value	Pointer to the attribute value buffer.
maxlen	This field is for internal use only. It is not currently used.

The PFS_FEALIST structure describes the list buffer and contains the total count and size of data returned. The caller must initialize this structure to define the total size of the list buffer and how many PFS_FEA structures may be placed in the buffer. The buffer itself needs no initialization.

The caller must initialize the len field to indicate the total size of the buffer. The count field must be initialized to the number of PFS_FEA elements which may be placed in the buffer. The PFS_FEA elements always start at the beginning of the buffer and are arranged to form a contiguous array.

The space remaining in the buffer (len - count * sizeof(PFS_FEA)) is used as storage space for attribute names and values.

PFS will return the total number of bytes written to the buffer in totlen and the total number of PFS_FEA elements used in totcnt.

Figure 7-16: Format of the PFS_FEALIST structure

len	0
totlen	4
cnt	8
totcnt	12
list	16

Table 7-16: Contents of the PFS_FEALIST structure

Field Name	Description
len	Total length, in bytes of the buffer pointed to by the "list" field.
totlen	Total length of all buffer space either used or required to complete the processing of the specified attribute list. If the function fails with an error of PFS_BuffTooSmall this field indicates to minimum size of the buffer to complete the operation.
cnt	Count of PFS_FEA entries in the buffer. The size of the data area of the buffer is calculated as [illegible] sizeof(PFS_FEA))

Table 7-16 (cont): Contents of the PFS_FEALIST structure

Field Name	Description
totcnt	Total number of attributes returned in the buffer. If the function fails with PFS_BufferTooSmall this field indicates the number of entries which need to be specified.
list	Pointer to the buffer containing both PFS_FEA elements (elements will be formatted on return) and the data area.

The PFS_GEA structure contains an attribute name to be located. The name is a binary string of arbitrary length. The caller may build an array of PFS_GEA elements to perform operations on multiple attributes. The array is passed to PFS thru the PFS_GEALIST structure list field.

Figure 7-17: Format of the PFS_GEA structure

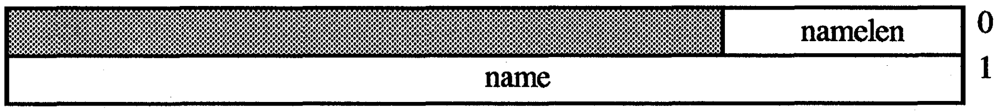


Table 7-17: Contents of the PFS_GEA structure

Field Name	Description
namelen	Length of the attribute to match
name	Attribute name buffer specifying the attribute name to be selected.

The PFS_GEALIST structure defines the attributes to be located for a get operation. The structure contains the total length of the array (PFS_GEA elements plus attribute name lengths) and the count of PFS_GEA elements in the array. The base of the array is passed in the PFS_GEALIST list field.

Figure 7-18: Format of the PFS_GEALIST structure

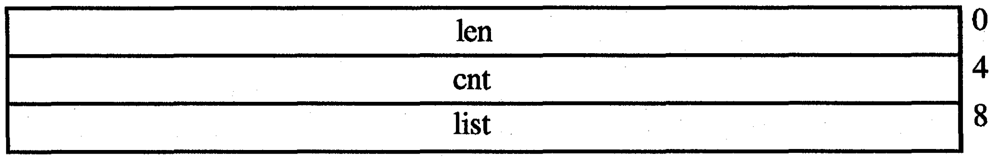


Table 7-18: Contents of the PFS_GEALIST structure

Field Name	Description
len	Total length, in bytes of the PFS_GEA array.
cnt	Count of elements in the PFS_GEA array.
list	Pointer to the PFS_GEA array.

7.5.12 PFS_MACSECUR

The PFS_MACSECUR structure is used for Macintosh security operations, PFS_getsecurity(), PFS_setsecurity() and PFS_checksecurity(). The structure contains the Macintosh user ID, group ID and permissions allowed for the various Macintosh security classes. PFS does not interpret the contents of this structure. However, it does undertand the format and applies the supplied mask such that individual fields may be modified without a read-modify-write sequence.

Figure 7-19: Format of the PFS_MACSECUR structure

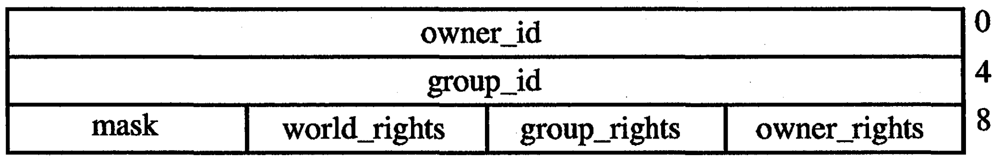


Table 7-19: Contents of the PFS_MACSECUR structure

Field Name	Description
owner_id	Macintosh file owner ID.
group_id	Macintosh owner's group ID.
owner_rights	Access rights for the file owner.
group_rights	Access rights for the members of the file's group.
world_rights	Access rights for all others.
mask	Mask of valid elements for get/set.

7.5.13 Stat structure

The stat structure is a Unix concept which is ported to various platforms for compatibility. The members of the structure may not have the same format nor the same implied function. The effectiveness of this structure outside of PFS is questionable.

NOTE

Currently the device name and file INODE are used to identify a file. The Unix device identifier is 32 bits in length and assumed to uniquely identify a device. VMS has no such concept. Currently the device member is defined as a 16 character array. This is a good application for a nameservice.

The INODE is also 32 bits and uniquely identifies a file within the Unix file system. Again VMS has no concept of a homogenous file system and assigns 48 bit file IDs relative to volumes. This means that to uniquely identify a file on VMS requires 176 bits. Is is not clear what the implications for other file systems may be.

Figure 7-20: Format of the Stat structure

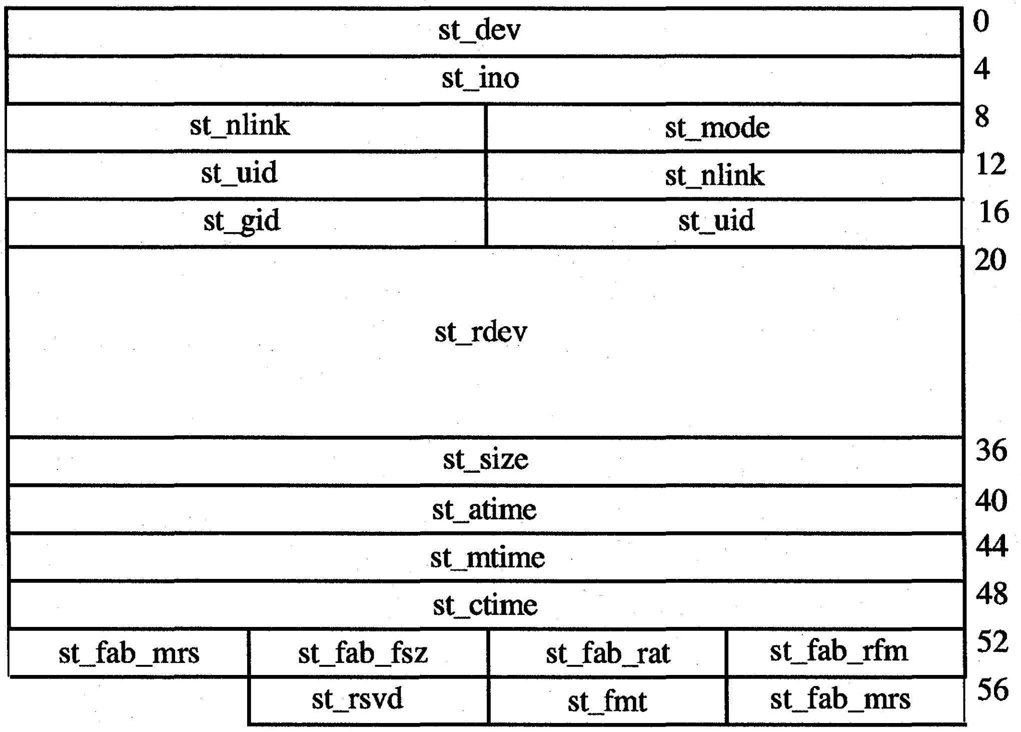


Table 7-20: Contents of the Stat structure

Field Name	Description
st_dev	Longword device identifier. This is currently defined as a pointer to a 16 byte structure. This field points to the st_rdev field.
st_ino	32 bit file identifier. This field is maintained by the file system library and is NOT unique across devices.
st_mode	Unix file format. PFS sets the S_IFMT field to indicate the file format. PFS uses thhe value S_IFDIRto determine if a file is a directory and assumes all file systems will set it accordingly. (It is not sufficient to use the PFS_ATTR directory bit as not all file services maintain this attribute). The file protection is converted to Unix format and stored here.
st_nlink	Unix. This field may be set by file system libraries but is otherwise unused.
st_uid	File owner ID. This longword contains the host file owner. This field has no significance outside of PFS. PFS does not use this field for security checks but it may be used by file system libraries.
st_gid	File owner group ID. This field contains the host file owner group ID. This field has no significance outside PFS. PFS does not use this field for security checks but it may be used by file system libraries.
st_rdev	This field contains the device lock name, currently 16 bytes.
st_size	File size. This field holds the file size in bytes. It is important to note that this is the native file size. This may include record format overhead and is likely to be of limited significance outsize of PFS.
st_atime	Access time in Unix time format. This is the host file system access time. While there may be a relationship between this time and the client access time this is not necessarily true.
st_mtime	Modification time in Unix format. This is the host file system modification time. See above disclaimer.
st_ctime	Creation time in Unix format. This is the host file system creation time. See above disclaimer.

Table 7-20 (cont): Contents of the Stat structure

Field Name	Description
st_fab_rfm	ODS-2 record format. This field is used by the ODS2 file system library and has no significance outside the library.
st_fab_rat	ODS-2 record attributes. This field is used by the ODS2 file system library and has no significance outside the library.
st_fab_fsz	ODS-2 fixed size. This field is the length of the fixed portion of a VFC file foramt. This field is used by the ODS2 file system library and has no significance outside the library.
st_fab_mrs	ODS-2 maximum record size. This field is the length of the largest possible record in the file. This field is used by the ODS2 file system library and has no significance outside the library.
st_fmt	Native file format.

As can be seen from the above descriptions, this structure is for internal use only. It is described here only because it is contained within data structures which pass across the interface. (and because there is a body of server code which references fields within the structure). No access to this structure can be allowed outside PFS as the fields vary amoung file systems.

7.5.14 Dirent structure

The dirent structure is used by PFS_getdents() and contains information about files contained in a directory. This data structure is inteded for server consumption (with the exception noted below) and should be defined as a native PFS data structure. This is likely for future PFS developements.

The data structure is always allocated in longword quantities within the PFS_getdents() buffer. The record length member is used to calculate the offset to the next structure within the buffer.

Figure 7-21: Format of the Dirent structure

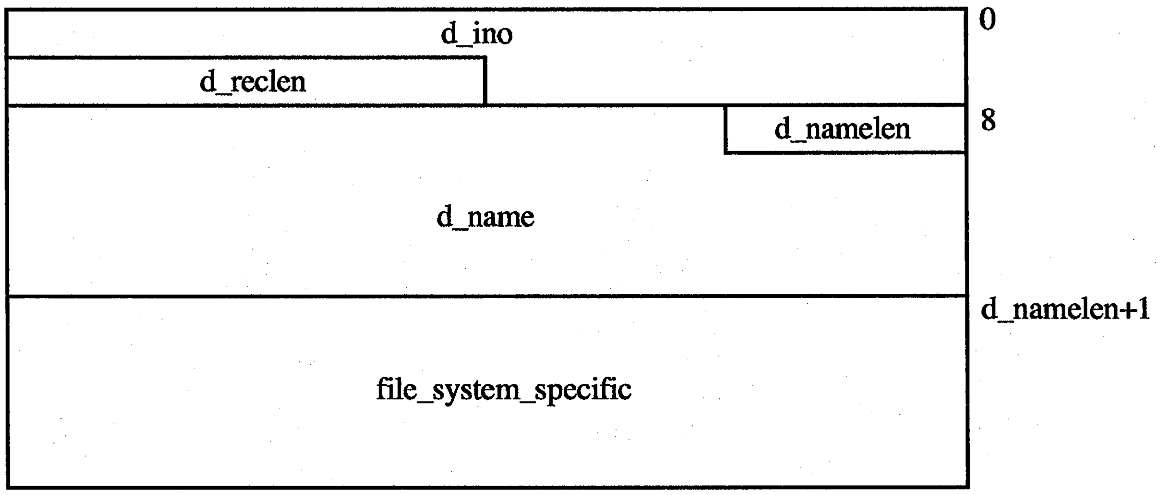


Table 7-21: Contents of the Dirent structure

Field Name	Description
d_ino	Opaque quantity. This field contans file location informaton used by PFS_dentpathid() to improve directory search performance.
d_reclen	Length of the entire record, rounded to the next longword.
d_namelen	Filename length. This field is the byte count of the filename.
d_name	Filename buffer. This field contains the actual filename in the requested namespace.
file_system_specific	File system specific data. This buffer is used to optimize access to the file contained in the d_name buffer. The size of this buffer and format is file system specific.

7.5.15 Utimebuf structure

The timbuf structure is used by PFS_utime() and PFS_futime(). It contains the last access time and last modification time for a file.

Figure 7-22: Format of the Utimbuf structure

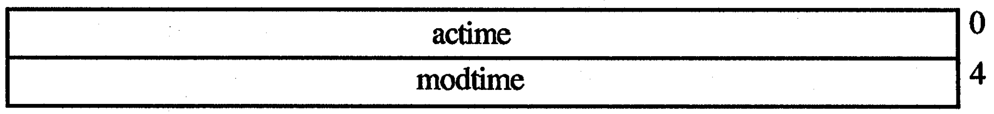


Table 7-22: Contents of the Utimbuf structure

Field Name	Description
actime	Access time in Unix format.
modtime	Modify time in Unix format.

7.6 Function error codes

PFS function may return error codes using one of two methods, PFS_errno or as the return value of a function. The initialization parameter [PFS]RETURN_ERRNO selects which method will be used.

Standard function return codes are defined below. The codes marked with an asterisk are only valid when [PFS]RETURN_ERRNO = 0. The PFS_errno codes will be stored in the global PFS_errno (established with PFS_setcontext) if [PFS]RETURN_ERRNO = 0. The PFS_errno codes will be returned as the value of a function if [PFS]RETURN_ERRNO = 1.

PFS_REVTAL codes:

PFS_SUCCESS	Operation completed normally
PFS_FAILURE *	Operation failed

PFS_FSSTATUS codes:

PFS_EXISTS	Path exists as specified.
PFS_NOEXISTS	Path does noit exist but the parent path does.
PFS_FAILED *	Alternate failure status.

PFS_CHKSTATUS codes:

PFS_ACCESS	Security check access allowed
PFS_NOACCESS	Security check access not allowed.
PFS_CHKFAILED *	Alternate failure status

PFS_errno codes:

PFS_InvalidParameter	Parameter supplied to function is invalid
PFS_BufferTooSmall	Buffer supplied to fnction is too small for current operation.
PFS_ResourceData	Source file has resource data and destination file system does not support resource data.
PFS_ExtendedAttrs	Source file has extended attributes and destination file system does not support extended attributes.
PFS_NotSupported	Function is not supported in current file system.
PFS_NoStartOffset	No start offset was supplied with function.
PFS_ShrinkFailed	Attempt to truncate a file has failed.
PFS_GrowFailed	Attempt to extend a file has failed.
PFS_NoCwd	No root was specified for a function and no working directory has been extablished.
PFS_NoSuchStream	Attempted access to a non existant file stream.
PFS_SecurityData	Source file has security data and destination file system does not support securty data.
PFS_BadPath	Path does not exist.
PFS_BadFile	File does not exist.
PFS_BadFd	An invalid file pointer was supplied.
PFS_FileLocked	Access to specified range is current not allowed due to a conflicting lock.
PFS_GeneralFailure	Function failure not related to a predefined error code.
PFS_NoAccess	Access to file or data is not allowed.
PFS_NoMemory	Insufficient memory for current operation.
PFS_DiskFull	Disk is full or exceeded disk quota.
PFS_AccessDenied	Access to a file or data is not allowed.
PFS_ParameterError	An invalid parameter was supplied to a function.
PFS_ActionInhibited	File attributes prohibit specified operation.

7.7 Initialization parameters

PFS initialization parameters are described in Appendix F.

8 PFS ROUTINE DESCRIPTIONS

The following section describes the routines available to servers. The server should include the file PFS.H in each module which uses these functions.

8.1. PFS_access *
8.2. PFS_faccess *

Description:

PFS_access checks the specified path for the specified access. This is a host security check only. NOS security must be checked separately. Note that PFS does not execute in the context of the host user. It is threfore possible to open a file and then check the file permissions. For VMS this may yeild some performance improvement for files to which the user has access. There will be a performance degradation for files to which the user has no access. It may be worth optimizing the success path and for such, PFS_faccess is provided.

NOTE

This is the only PFS function which verifies host access to a file. The server should call this function when it needs to verify a specific access.

Alternately, each function which needs to perform a security check can be modified to accept the PFS_USER structure.

Synopsis:

#include <pfs.h>

PFS_RETVAL PFS_access (PFS_PATHID *pathid, int perms, PFS_USER *user)

PFS_RETVAL PFS_faccess (PFS_FID *fp, int perms)

Arguments:

pathid	Resolved pathid for path to check. This arrument is returned from PFS_getpathid().
fp	Open file pointer. The argument is returned from PFS_open().
perms	Unix style permission code. The following bits are defined:
000	File exists
001	Execute access
002	Write/Delete access
004	Read access
user	Pointer to PFS_USER structure previously obtained with PFS_getuser().

Translations taken from "Programming in VAX-11 C".

Return values:

PFS_SUCCESS	Access is allowed

PFS_FAILURE	No access or invalid path

8.3. PFS_canceldesc *

Description:

PFS_canceldesc is used to cancel a set of cache buffers obtained via PFS_getcachedesc(). This function is used to complete a cache write sequence abnormally.

The normal sequence for cache writes in PFS_getcachedesc() followed by a PFS_writedesc(). If the write data can not be obtained or if there is an error during the processing of write data the descriptors may be released thru PFS_canceldesc(). One of the two functions, PFS_writedesc() or PFS_canceldesc(), must be called after calling PFS_getcachedesc().

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_canceldesc (PFS_FID *fp, struct buffer_descriptor **desc)
```

Arguments:

fp	Open file pointer for file in which write was initiated.
desc	Address of pointer to cache descriptor list to cancel.

Return values:

PFS_SUCCESS	Descriptors returned to cache
PFS_FAILURE	Invalid file pointer or failure to release descriptors

8.4. PFS_chdir
8.5. PFS_fchdir

Description:

PFS_chdir sets the current working directory. Note that the process structure of PFS is such that all threads executing in the process will see this default. It is threfore required that the server save and restore this default on thread switch. It is furtehr required that all thread switching performed by PFS be routed thru the server to allow these tasks to be completed.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_chdir (PFS_PATHID *pathid, PFS_USER *user)

PFS_RETVAL PFS_fchdir (PFS_FID *fp)
```

Arguments:

pathid	Resolved pathid pointing to a directory.
fp	Open file pointer for a directory. Only PFS_open() will return this pointer.
user	Pointer to PFS_USER structure previously obtained with PFS_getuser().

Return values:

PFS_SUCCESS	Default set
PFS_FAILURE	Invalid pathid or fp

8.6. PFS_checksecurity

Description:

PFS_checksecurity will traverse the directory structure specified by the pathid structure and call an action routine with the requested security data at each level. The action routine determines if the requested access is to be allowed or if additional path members must be checked.

The action routine is specified as follows (note the only difference is the interpretation of the security block:

For PFS_LMXSECURE

PFS_CHKSTATUS rtn (PFS_PATHID *pathid, PFS_EAOPS *eaopsp, param)

For PFS_MACSECURE

PFS_CHKSTATUS rtn (PFS_PATHID *pathid, PFS_MACSECUR *eaopsp, param)

The routine may return one of the following values:

PFS_ACCESS	Access is allowed, no further checks are necessary
PFS_NOACCESS	Access is not allowed, no further checks are necessary
PFS_CONTINUE	Access at this level is allowed, continue with the next level in the path.
PFS_CHKROOT	Access is allowed at this level, skip all intermediate levels and check the root directory.
PFS_CHKFAILED	Check function failed. Access is not allowed.

The parameter passed to the action routine is likley a structure pointer which will hold the requested access, directory level, user ID or any information the server needs to perform the check.

The PFS_LMXSECURE and PFS_MACSECURE algorithms differ in that PFS_LMXSECURE space will return failure if all levels have been checked and access has not been granted. PFS_MACSECURE will return success if all levels are checked and access has not been denied.

NOTE

To promote the separation of security space and the file system, the algorithmic difference described above could be specified in a parameter to the function. This is not deemed necessary at this time.

Synopsis:

#include <pfs.h>

```
PFS_CHKSTATUS PFS_checksecurity (PFS_PATHID *pathid,
                     PFS_SECURSPACE *securspace, PFS_EAOPS
                     *eaopsp, PFS_CHKSTATUS (*rtn)(), unsigned param)

PFS_CHKSTATUS PFS_checksecurity (PFS_PATHID *pathid,
                     PFS_SECURSPACE *securspace, PFS_MACSECUR
                     *eaopsp, PFS_CHKSTATUS (*rtn)(), unsigned param)
```

Arguments:

pathid	Resolved pathid pointing to file or directory to be checked.
securspace	Security space. PFS_LMXSECURE and PFS_MACSECURE are defined.
eaopsp	The eaopsp member points to the security data structure as defined by PFS_getsecurity(). The structure is either a PFS_EAOPS structure (LMX security space) or a PFS_MACSECUR structure (Macintosh security space).
rtn	Action routine to call
param	Parameter to pass to routine

Return values:

PFS_ACCESS	Access allowed
PFS_NOACCESS	Access not allowed
PFS_CHKFAILED	Function failed

8.7. PFS_chmod
8.8. PFS_fchmod

Description:

PFS_chmod changes the file protection of a host file. Note that there is no access checking with respect to the client for which this function is being executed. It is the responsibility of the server to determine if the client has the requisite privileges to affect the change.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_chmod (PFS_PATHID *pathid, mode_t mode,
                      PFS_USER *user)

PFS_RETVAL PFS_fchmod (PFS_FID *fp, mode_t mode)
```

Arguments:

pathid	Resolved pathid returned from PFS_getpathid().
fp	Open file pointer.
mode	New file protection. The following bits are defined:
0400	Owner : Read
0200	Owner : Write
0100	Owner : Execute
0040	Group : Read
0020	Group : Write
0010	Group : Execute
0004	World : Read
0002	World : Write
0001	World : Execute
user	Pointer to PFS_USER structure previously obtained with PFS_getuser().

System is always given the same protection as Owner. Write privilege implies Delete. Translations taken from "Programming in VAX-11 C".

Return values:

PFS_SUCCESS	Protetion changed
PFS_FAILURE	Invalid path

8.9. PFS_chown
8.10. PFS_fchown

Description:

PFS_chown changes the host owner of a file. The NOS owner is not affected. It is expected that this function be used in conjunction with PFS_setsecurity() to affect an owner change consistent with both NOS and host file systems. Note that there is no access checking with respect to the client for which this function is being executed. It is the responsibility of the server to determine if the client has the requisite privileges to affect the change.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_chown (PFS_PATHID *pathid, uid_t uid, gid_t gid,
                      PFS_USER *user)

PFS_RETVAL PFS_fchown (PFS_FID *fp, uid_t uid, gid_t gid)
```

Arguments:

pathid	Resolved pathid from PFS_getpathid()
fp	Open file pointer
uid	User identification code
gid	Group identification code
user	Pointer to PFS_USER structure previously obtained with PFS_getuser().

Return values:

PFS_SUCCESS	Owner changed
PFS_FAILURE	Invalid path

8.11. PFS_close

Description:

PFS_close will close an open file. This function will flush any modified buffers, remove all locks associated with the file and update the volume modification time, if required. This call should be made when a file is actually to be closed (i.e. after open file cache expiration time).

NOTE

It is possible that the PFS_FID may be shared among threads of the same process. If this is the case a reference count will be decremented and the actual file close will only occur when the count reaches zero.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_close (PFS_FID *fp)
```

Arguments:

fp	Open file pointer

Return values:

PFS_SUCCESS	File closed
PFS_FAILURE	Invalid file pointer

8.12. PFS_closeandpurge *

Description:

PFS_closeandpurge will close an open file and then purge it. This function should be used when a temporary file is to be deleted.

NOTE

It is possible that the PFS_FID may be shared among threads of the same process. If this is the case a reference count will be decremented and the actual file close will only occur when the count reaches zero.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_closeandpurge (PFS_FID *fp)
```

Arguments:

fp	Open file pointer

Return values:

PFS_SUCCESS	File closed and deleted
PFS_FAILURE	Invalid file pointer

8.13. PFS_copyfile

Description:

PFS_copyfile copies a file from one source to a destination. The source and destination may be in different file system libraries. The function is subject to source file system attribute PFS_ATTR.attr_bits.no_copy.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_copyfile (PFS_PATHID *source, PFS_PATHID *dest,
                         PFS_SUPORT_STREAMS dostream,
                         PFS_COPY_ACTION action, PFS_USER *user)
```

Arguments:

source	Resolved pathid structure for source file. The file must not have the PFS_ATTR no_copy bit set.
dest	Resolved pathid structure for destination file. The file must not reside in a read only file system.
dostream	Action to be taken if the destination file system does not support all streams of the source file.

PFS_NONE_OK	Copy the supported streams only. The remaining streams are lost.
PFS_MUST_RESOURCE	If the destination does not support resource streams and the source file has a resource stream then fail.
PFS_MUST_EXTATTRS	If the destination does not support extended atrtributes and the source file has extended attrbiutes then fail.
PFS_MUST_SECURITY	If the destination does not support security data and the source has security data then fail.
PFS_MUST_ALL	If the destination does not support either resource streams nor extended attributes streams and the source file has either then fail.

action	Action to be taken if the destination file already exists.

PFS_TRUNCATE	Truncate all destination streams.
PFS_APPEND	Append PFS_PRIMARY data stream. Truncate the resource stream. Leave extended attributes stream unchanged. The source extended attributes are lost.

user	Pointer to PFS_USER structure previously obtained with PFS_getuser().

Return values:

PFS_SUCCESS	File copied
PFS_FAILURE	Invalid path, conflicting file systems or copy protect

8.14. PFS_create

Description:

PFS_create creates a new file (PFS_PRIMARY stream only) or truncates an existing file. The file is left open after the function executes.

PFS_create accepts the user ID to establish the host owner. This is generally the mapped host user specified by the PFS_USER parameter. If the owner is not specifed the default server process owner is used. The group ID may supply additional information about the owner. This field is not used for VMS based servers. The owner is only set if the file is actually created. An existing file's owner will not be modified.

PFS_create accepts the default file protection to be applied to a new file. The file protection is only set if the file is created. An existing file's protection will not be modified.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_create (PFS_PATHID *pathid, mode_t mode, uid_t uid,
                       gid_t gid, PFS_CREATE_TYPE type, PFS_FID **fp,
                       PFS_USER *user)
```

Arguments:

pathid	Resolved pathid from PFS_getpathid()
mode	File protection. Set PFS_chmod() for a description.
uid	Host file owner user ID.
gid	Host file owner group ID.
type	Type of file to create. The field has one of the following values:

PFS_CREATEIT	If the file already esists then truncate it.
PFS_MAKETMP	Create a temporary file. Pathid points to the directory in which to create the file. The filename is generated.
PFS_MAKNEW	If the file exists PFS_create() fails.

fp	Pointer to return file pointer. The file pointer is allocated by PFS_create() and must be returned on PFS_close().

user	Pointer to PFS_USER structure previously obtained with PFS_getuser().

Return values:

PFS_SUCCESS	File created
PFS_FAILURE	Invalid path or file exists and PFS_MAKENEW specified

8.15. PFS_delete

Description:

PFS_detete deletes a file. If the PFS_ATTR bit no_purge is set the file is moved to a holding area. [Where ??]. If no_purge is not set then the file is actually deleted.

NOTE

The PFS_ATTR no_purge bit is used to support Netware's SCAVANGE function. This feature is not currently supported. This feature is not related to the Macintosh concept of a trash can in which deleted files are moved to a trash folder. The Macintosh server must provide this function in terms of PFS_rename.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_delete (PFS_PATHID *pathid, PFS_USER *user)
```

Arguments:

pathid	Resolved pathid structure from PFS_getpathid().
user	Pointer to PFS_USER structure previously obtained with PFS_getuser().

Return values:

PFS_SUCCESS	File deleted
PFS_FAILURE	No access, file not found

8.16. PFS_dentpathid *

Description:

PFS_dentpathid converts a directory "struct dirent" to a PFS_PATHID structure. This function is used to improve performance of directory search functions. If a file system does not support this function or if sufficient information is not in the struct dirent then the file system should return failure. PFS_dentpathid() will then call PFS_getpathid() using the filename from the "struct dirent".

It is assumed that PFS_chdir() has been called to set the default directory to that being searched prior to this call. While PFS_dentpathid() does not use the default directory, fallbacks to PFS_getpathid() will.

Synopsis:

```
#include <pfs.h>
#include <dirent.h>

PFS_RETVAL PFS_dentpathid (PFS_FID *fp, struct dirent *dirent,
                           PFS_PATHID *pathid)
```

Arguments:

fp	Open file pointer to directory to be searched
dirent	Struct dirent from PFS_getdents().
pathid	Resulting PFS_PATHID structure for file.

Return values:

PFS_EXISTS	Path exists as specified.
PFS_NOEXIST	Path does not exist but the parent path does (i.e. a new file specification).
PFS_FAILED	Neither parent nor path exists.

8.17. PFS_didpathid *

Description:

PFS_didpathid will accept a default directory structure instead of the root string as in PFS_getpathid(). The remaining function is identical to PFS_getpathid().

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_didpathid (PFS_CWD *dirid, char *path,
                          PFS_NAMESPACE namespace, PFS_PATHID *pathid)
```

Arguments:

dirid	PFS_CWD structure as returned by PFS_diridfunc. The path member of the structure is not used. The directoryID member is used as the root directory.
path	NOS path name.
namespace	NOS path name space identifier. This argument specifies the namespace in which the path resides.
pathid	Resolved pathid structure.

Return values:

PFS_EXISTS	Path exists as specified.
PFS_NOEXIST	Path does not exist but the parent path does (i.e. a new file specification).
PFS_FAILED	Neither parent nor path exists.

8.18. PFS_diridfunc

Description:

PFS_diridfunc supports translation of directory IDs. The function will open a set of IDs, close a set of IDs or translate the IDs into native file system structures. The back translation to path string is somewhat expensive on VMS and is not required for lookups. The interface has been changed to return a structure of the same form as used by PFS_cwd(). This structure will only carry the full VMS directory ID and may be used as input to the function PFS_didpathid().

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_diridfunc (PFS_DIRID_CMD cmd, char *root, unsigned
                          long dirid, PFS_CWD *dirptr)
```

Arguments:

cmd	Directory ID command. The command is one of the following:	
	PFS_DIRID_OPEN	Open a new set of directory IDs. The root argument carries the volume name to be opened.
	PFS_DIRID_GET	Translate the given directory ID to a PFS_CWD structure. The root argument specifies the volume.
	PFS_DIRID_CLOSE	Close a set of directory IDs. The root argument carries the name of the volume to close.
	PFS_DIRID_CLEANUP	Close all directory IDs.
root	Volume root directory.	
dirid	Directory ID to translate	
dirptr	Return directory ID structure. This structure may contain the path name as a string or the native directory ID or both.	

Return values:

PFS_SUCCESS	Directory ID translated
PFS_FAILURE	Invalid directory ID or no directory ID set open.

8.19. PFS_diridinit

Description:

PFS_diridinit initializes the generation of directory IDs for file systems which do not direcltly support directory IDs.

Synopsis:

#include <pfs.h>

void PFS_diridinit (PFS_DIRIDS_MATTER dodorods, unsigned long
                        *diridptr)

Arguments:

dodirids	Flag to indicate whether to generate directory IDs. The flag has the following values:	
	PFS_DIRIDS	Generate directory IDs for PFS_mkdir(). PFS_getattr() will return the generated ID.
	PFS_NODIRIDS	Do not generate directory IDs. The file system will handle the function directly.
diridptr	Pointer into shared memory for the next unique directory ID.	

Return values:

None

8.20. PFS_filesize
8.21. PFS_ffilesize

Description:

PFS_ffilesize returns the size of an open file. The function may be required to read the file to determine its size. If so, the filesize will be saved in the ACE associated with the file.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_filesize (PFS_PATHID *pathid, PFS_DATA_STREAM
                         stream, off_t *size, PFS_USER *user)

PFS_RETVAL PFS_ffilesize (PFS_FID *fp, off_t *size)
```

Arguments:

pathid	Resolved pathid structure as returned by PFS_getpathid().
stream	Data stream to obtain size of.
fp	Open file pointer
size	Pointer to return file size longword
user	Pointer to PFS_USER structure previously obtained with PFS_getuser().

Return values:

PFS_SUCCESS	Return size is valid
PFS_FAILURE	Invalid file pointer

8.22. PFS_freeuser *

Description:

PFS_freeuser releases the structure obtained with PFS_getuser(). This function must be called when a PFS_USER structure obtained with PFS_getuser() is no longer needed. The PFS_USER structure is dynamically allocated and PFS uses its own memory allocation routines. This function provides the only mechanism to dispose of the PFS_USER structure.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_freeuser (PFS_USER *user)
```

Arguments:

user	Pointer to PFS_USER structure previously obtained with PFS_getuser().

Return values:

PFS_SUCCESS	Disposed of PFS_USER structure
PFS_FAILURE	Error in dispose

8.23. PFS_fsync

Description:

PFS_fsync flushes all modified data associated with a file. This includes modified header data.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_fsync (PFS_FID *fp)
```

Arguments:

fp	Open file pointer

Return values:

PFS_SUCCESS	File flushed
PFS_FAILURE	Invalid file pointer

8.24. PFS_fullpath

Description:

PFS_fullpath returns the full file specification for an open file.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_fullpath (PFS_FID *fp, char *pathbuf, int buflen)
```

Arguments:

fp	Open file pointer
pathbuf	Buffer for return file specification
buflen	Length of return buffer

Return values:

PFS_SUCCESS	Path written to buffer
PFS_FAILURE	Invalid file pointer to buffer too small

8.25. PFS_getattr
8.26. PFS_fgetattr

Description:

PFS_getattr will return the file attributes structure. The attributes structure is described in section 7.5.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_getattr (PFS_PATHID *pathid, unsigned long mask,
                        PFS_ATTR *attrp, PFS_USER *user)

PFS_RETVAL PFS_fgetattr (PFS_FID *fp, unsigned long mask, PFS_ATTR
                        *attrp)
```

Arguments:

pathid	Resolved pathid structure from PFS_getpathid()
fp	Open file pointer
mask	Mask of elements requested. There is one bit in the mask for each field in the PFS_ATTR structure. This mask has the exact same format as that in the PFS_ATTR structure.
attrp	Pointer to return attributes structure.
user	Pointer to PFS_USER structure previously obtained with PFS_getuser().

Return values:

PFS_SUCCESS	Attributes updated
PFS_FAILURE	Invalid parameters

8.27. PFS_getcachedesc *

Description:

PFS_getcachedesc will obtain a set of cache buffer descriptors to be used as write buffers. The buffers are released to the cache with PFS_writedesc(). The cache buffers will contain valid data from the cache block start to the offset specified by the difference between the offset and the relative offset in the cache block. The same applies to the data in the last block of the descriptor beyond the write range..

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_getcachedescdesc (PFS_FID *fp, unsigned int nbytes,
                        off_t offset, struct buffer_descriptor **desc)
```

Arguments:

fp	Open file pointer.
nbytes	Size of write range.
offset	Offset releative to the start of the stream from which to read.
desc	Pointer to receive data description. [Need specification of work element for data cache].

Return values:

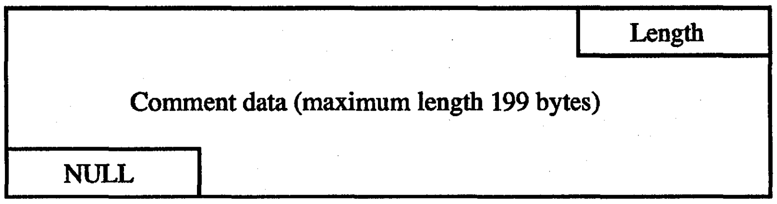
PFS_SUCCESS	Data read
PFS_FAILURE	Invalid parameters

8.28. PFS_getcomment

Description:

PFS_getcomment will return the comment record associated with a file. The comment is limited to 199 bytes. The first byte of the comment buffer contains the length of the comment string. The string is NULL terminated.

Figure 8-1: Format of the File Comment Buffer



Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_getcomment (PFS_PATHID *pathid, char *comment, int
                           buflen, PFS_USER *user)
```

Arguments:

pathid	Resolved pathid from PFS_getpathid().
comment	Return buffer for comment.
buflen	Length of return buffer.
user	Pointer to PFS_USER structure previously obtained with PFS_getuser().

Return values:

PFS_SUCCESS	Coment returned
PFS_FAILURE	Invalid parameters

8.29. PFS_getcwd

Description:

PFS_getcwd returns the current working directory.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_getcwd (PFS_CWD *cwd)
```

Arguments:

cwd	Pointer to working directory structure

Return values:

PFS_SUCCESS	Directory returned
PFS_FAILURE	No directory set

8.30. PFS_getdents

Description:

PFS_getdents returns directory entries in a struct dirent buffer. The buffer is written with as many full directory entries as will fit (or as many as are in the directory). The struct dirent is defined in section 7.5.

The function should be called until the bytesread paramater indicates zero bytes written to the output buffer. The function will not fail when the end of the directory is reached.

The offset argument must be set to zero before the first call to PFS_getdents is made. PFS_getdents will maintain its current context in this location. The location may be cleared to reset the directory list. Any other value is undefined and will cause PFS_getdents to behave unpredictably.

The contents are returned mapped to the namespace supplied. All filenames are returned in the semantics of the supplied namespace, regadless of whether they may be legal in that namespace. It is the server's responsibility to filter the contents of the dirent buffer.

Synopsis:

```
#include <pfs.h>
#include <dirent.h>

PFS_RETVAL PFS_getdents (PFS_FID *fp, struct dirent *direntp, unsigned
                         int nbytes, off_t *offset, PFS_NAMESPACE
                         namespace, unsigned int bytesread)
```

Arguments:

fp	Open file pointer for the directory to be enumerated.
direntp	Buffer to receive directory entries.
nbytes	Size of the buffer.
offset	Pointer to receive context longword for resuming directory enumeration. This longword must not be modifed bewteen calls to PFS_getdents.
namespace	Namespace in which to return directory entries.
bytesread	Return count of how many bytes were written to the output buffer.

Return values:

PFS_SUCCESS	Buffer written (including no entries)
PFS_FALURE	Invalid parameters

8.31. PFS_geterrno *

Description:

PFS_geterrno is used to obtain the last error encountered by PFS. The global location PFS_errno has been replaced by this call to facilitate threaded execution and to eliminate global locations shared between facilities.

This function is provided for backward compatibility only. PFS may be configured to return the actual error encountered as the value of each PFS function. This is the preferred method of error reporting and will become the only method in future releases.

The use of PFS_geterrno() requires that each thread establish the pointer to its PFS_errno location via PFS_setcontext(). This must be done on every thread switch. This is both inefficient and cumbersome for the callers of PFS. This mechanism will be removed in future releases.

Synopsis:

```
#include <pfs.h>

int PFS_geterrno (void)
```

Arguments:

None

Return values:

Last error encountered by PFS for the current thread.

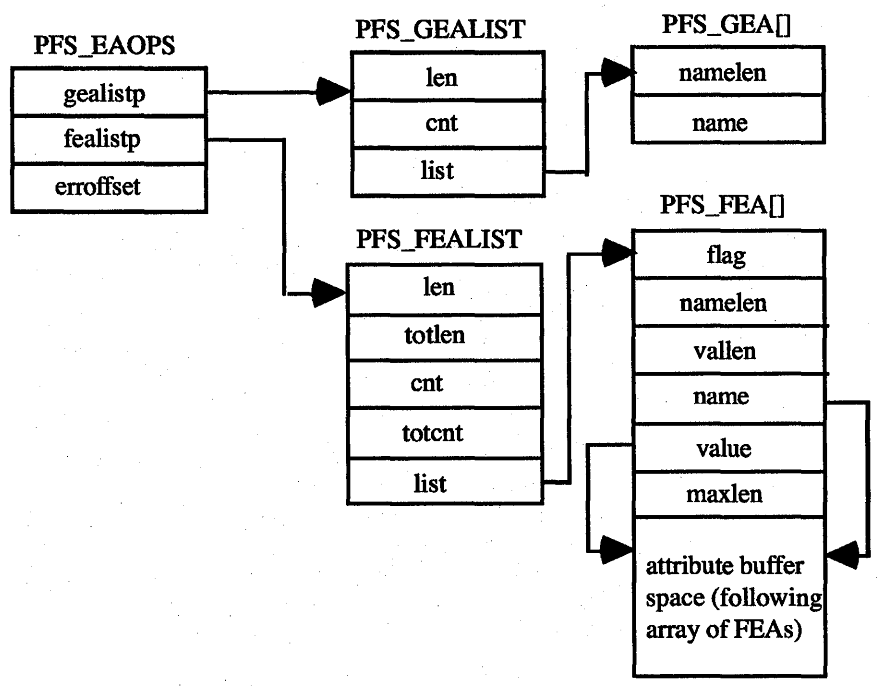
8.32. PFS_getextattr
8.33. PFS_fgetextattr

Description:

PFS_getextattr will return the extended attributes associated with a file. The interface uses a number of structures to carry requested attributes and return attributes found on the file.

The arrangement of structures is shown below:

Figure 8-2: Layout of PFS_EAOPS Structures



The PFS_EAOPS structure contains a pointer to the PFS_GEALIST structure and the PFS_FEALIST structure. The erroffset member will be written with the last offset written in the PFS_FEA array if the function fails.

The PFS_GEALIST structure is used to describe names of attributes to be returned. If all names are to be returned, the pointer should be specified as PFS_ALLFEAS. The PFS_GEALIST structure contains a pointer to an array of PFS_GEA elements. Each element of this array is a named attribute. This structure is read-only to PFS.

The PFS_GEA structure contains a pointer to the name buffer and the length of the name. Names must be specified explicitly, there is no wildcard matching and names are matched case sensitive. The array is read-only to PFS.

The PFS_FEALIST structure is used to describe the return attributes array. The length of the array and the number of elements present is specified in this structure. The caller must initialize this structure with the total size of the PFS_FEA buffer and the number of elements in the buffer. The buffer must be large enough to hold the number of PFS_FEA elements PLUS additional buffer space to hold the name and value assigned to each requested attribute. The buffer space left for names and return values may be calculated as follows:

```
bytesleft = len - cnt * sizeof(PFS_FEA);
```

The number of bytes written (or the number of bytes required to complete the function) will be returned in totallen. The number of matched elements will be returned in totalcnt. The PFS_FEA buffer should contain the same number of entries as the PFS_GEA structure. Attributes will be written to the same offset in the PFS_FEA array as they were requested in the PFS_GEA array. If the PFS_GEALIST is specified as PFS_ALLFEAS then the PFS_FEA array should be large enough to hold all expectes attributes. If the buffer is not large enough a new one may be allocated using the totallen and totalcnt fields returned and the function may be retried with the larger buffer. Alternatly, the PFS_stat function may be used to obtain the total byte count of the extended attributes stream. This function will not return the count of elements.

The PFS_FEA array is written by PFS with the return attributes. It requires no initialization.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_getextattr (PFS_PATHID *pathid, PFS_EAOPS *eaopsp,
                           PFS_USER *user)

PFS_RETVAL PFS_fgetextattr (PFS_FID *fp, PFS_EAOPS *eaopsp)
```

Arguments:

pathid	Resolved pathid from PFS_getpathid().
fp	Open file pointer
eaopsp	Pointer to return extended attributes structure. [This structure is not yet defined as there is still question as to whether we support extended attributes].
user	Pointer to PFS_USER structure previously obtained with PFS_getuser().

Return values:

PFS_SUCCESS	Extended attributes written to buffer
PFS_FAILURE	Invalid parameters

8.34. PFS_getpathid

Description:

PFS_getpathid resolves a NOS file path given the top of the directory tree, the NOS path and NOS type. PFS_getpathid locates the file system which handles this path and sets the file system library dispatch vectors for future reference.

PFS_getpathid calls the following library functions:

FSLIB_claim	File system is asked to claim the path. If a file system claims a path then it will be responsible for all future requests for that path.
FSLIB_convert	Convert filename to native file specification
FSLIB_lookup	Locate the file
FSLIB_stat	Return file location, type, size, etc.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_getpathid (char *root, char *path, PFS_NAMESPACE
                    namespace, PFS_PATHID *pathid)
```

Arguments:

root	Top of directory tree or directory which corresponds to the volume root.
path	NOS file path.
namespace	Namespace in which path resides. The following values are defined:

PFS_DOSNAME	DOS filename format
PFS_MACNAME	Macintosh filename format
PFS_VMSNAME	VMS filename format
PFS_UNIXNAME	Unix name format
PFS_NATIVENAME	Native file system format

pathid	Return resolved pathid structure

Return values:

PFS_EXISTS	Path exists as specified.
PFS_NOEXIST	Path does not exist but the parent path does (i.e. a new file specification).
PFS_FAILED	Neither parent nor path exists.

8.35. PFS_getpathidX *

Description:

PFS_getpathidX resolves a NOS file path given the top of the directory tree, the NOS path and NOS type. PFS_getpathidX uses the supplied PFS_ROOTID to locate the file system which handles this path. This allows optimizations for file system which claim paths based on root specification alone.

PFS_getpathidX calls the following library functions:

FSLIB_convert	Convert filename to native file specification
FSLIB_lookup	Locate the file
FSLIB_stat	Return file location, type, size, etc.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_getpathidX (PFS_ROOTID *rootid, char *path,
                           PFS_NAMESPACE namespace, PFS_PATH_TYPE
                           pathtype, PFS_PATHID *pathid)
```

Arguments:

rootid — Top of directory tree or directory which corresponds to the volume root. This root is passed in a PFS_ROOTID struction previously obtained with PFS_getrootid().

path — NOS file path.

namespace — Namespace in which path resides. The following values are defined:

PFS_DOSNAME	DOS filename format
PFS_MACNAME	Macintosh filename format
PFS_VMSNAME	VMS filename format
PFS_UNIXNAME	Unix name format
PFS_NATIVENAME	Native file system format

pathtype — Type of path to be processed. The following values are defined:

PFS_FILE_PATH	Path should be found as a file
PFS_DIRECTORY_PATH	Path should be found as a directory
PFS_ANY_PATH	Path may be found as either. The search order is always file first then directory.

pathid	Return resolved pathid structure

Return values:

PFS_EXISTS	Path exists as specified.
PFS_NOEXIST	Path does not exist but the parent path does (i.e. a new file specification).
PFS_FAILED	Neither parent nor path exists.

8.36. PFS_getprintident *
8.37. PFS_fgetprintident *

Description:

PFS_getprintident returns file identification information in the PFS_IDENT structure. This structure is used primarity by the print subsystem to identify a file.

The PFS_IDENT structure is defined in section 7.5.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_getprintident (PFS_PATHID *pathid, PFS_IDENT
                              *identp)

PFS_RETVAL PFS_getprintident (PFS_FID *fp, PFS_IDENT *identp)
```

Arguments:

pathid	Resolved pathid structure as returned by PFS_getpathid().
fp	Open file pointer.
identp	Pointer to return identification structure.

Returns:

PFS_SUCCESS	Print identification returned
PFS_FAILURE	Insufficient information

8.38. PFS_getrootid *

Description:

PFS_getrootid will obtain a PFS_ROOTID structure describing the specified path root. The structure may be used as input to PFS_getpathidX. This eliminates the need for repetive path claims for file systems which claim paths based on the root alone.

The PFS_ROOTID structure is defined in section 7.5.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_getrootid (char *root, PFS_NAMESPACE namespace,
                          PFS_ROOTID *rootid)
```

Arguments:

root	ASCIZ string specifying a native file specification to be used as the root path.
namespace	Namespace in which this root will operate.The namespace is used to differentiate basic path types in some file systems. This may preclude using the same rootid to handle incompatible namespaces. Currently Macintosh and DOS paths may not be handled with a common rootid. DOS, OS/2, VMS and Unix paths may be handled with a common rootid.
rootid	Return rootid structure.

Returns:

PFS_SUCCESS	Root successfully located.
PFS_FAILURE	Invalid root specification.

8.39. PFS_getsecurity *
8.40. PFS_fgetsecurity *

Description:

PFS_getsecurity returns stored NOS security data for a given object. The function does not interpret the data.

Lan Manager security data is stored as a set of named objects. The name may be any string and the data is variable length. PFS_getsecurity will retrieve named objects if requested. The semantics are identical to those for PFS_getextattr(). Lan Manager security data is accessed by specifying PFS_LMXSECURE as the securspace argument.

Macintosh security data is stored in the Macintosh ACE. The format of the Macintosh security data returned is identical to that stored in the Macintosh ACE. Macintosh security data is accessed by specifying PFS_MACSECURE as the securspace argument. This interface does not use the PFS_EAOPS structure. The buffer supplied will be written with the security data from the Macintosh ACE.

Note that the PFS_GEA structure is used to request named security data. This structure is initialized by the caller. The PFS_FEA structure holds one record per requested named security data, even if the data does not exist. The vallen field will be set to zero in the event that the data does not exist. In this manner there is a one-to-one correspondence between input array offsets and output array offsets.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_getsecurity (PFS_PATHID *pathid, PFS_SECURSPACE
                        securspace, void *securp, PFS_USER *user)

PFS_RETVAL PFS_fgetsecurity (PFS_FID *fp, PFS_SECURSPACE
                        securspace, void *securp)
```

Arguments:

pathid	Resolved pathid structure returned by PFS_getpathid().
fp	Open file pointer
securspace	Security data space to be modified. The following values are defined:

PFS_LMXSECURE	Lan Manager security space.
PFS_MACSECURE	Macintosh security space.

securp	Pointer to security data access structure. For PFS_LMXSECURE the structure is identical to the extended attributes structure. For PFS_MACSECURE the data starts

	at offset "ownerID" and is returned exactly as specified in the Macintosh ACE. The data is 11 bytes in length.
user	Pointer to PFS_USER structure previously obtained with PFS_getuser().

Return values:

PFS_SUCCESS	Returned attributes
PFS_FAILURE	Invalid parameters

8.41. PFS_getsecuritymode *

Description:

PFS_getsecuritymode will return the current system security mode. The mode is one of PFS_HOST_SECURITY, PFS_CREATOR_SECURITY or PFS_NOS_SECURITY. The system security mode is set by PFS at startup and may be changed using PFS_setsecuritymode().

Synopsis:

```
#include <pfs.h>

PFS_SECURITY_MODE PFS_getsecuritymode (void)
```

Arguments:

None

Return values:

System security mode

8.42. PFS_getuser *

Description:

PFS_getuser returns information about the specified host user in a PFS_USER structure. This structure is used for access checking functions PFS_acess() and PFS_faccess().

The function reads information from the system User Authorization File (UAF) and returns the user identification, rights and privileges, account and username.

It is the callers responsibility to release the memory associated with the structure.PFS_freeuser() is provided for this purpose. Since PFS uses its own memory allocation routines PFS_freeuser() must be called to dispose of the structure when it is no longer needed.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_getuser (char *username, PFS_USER **user)
```

Arguments:

username	Host username for which information is desired
user	Return user structure defining user rights and privileges.

Return values:

PFS_SUCCESS	Obtained user info
PFS_FAILURE	No such user

8.43. PFS_init

Description:

PFS_init initializes the file system interface, loads and calls all file system libraries. Addon libraries are located in the directory pointed to by PWRK$ADDON_LIBRARY: and must named PWRK$name_FSLIB.EXE, where name is the file system name. The file system library must have a universal symbol of the form name_init. For example, the FAT file system would be found as PWRK$FAT_FSLIB.EXE and would have a universal symbol FAT_init. The universal symbol is the entry point to the library and is responsible for initializing the PFS_LIB_ENT structure, including setting up the library vectors.

PFS_init must be called prior to any PFS file access.

Synopsis:

```
#include <pfs.h>

void PFS_init (void)
```

Arguments:

None

Return values:

None

8.44. PFS_lock

Description:

PFS_lock establishes a byte range lock on the file in the underlying file system. This function is provided for establishing byte range locks in the file system itself. Btye range locks are handled withing PATHWORKS by the PATHWORKS Lock Manager and may not involve the file system.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_lock (PFS_FID *fp, short type, off_t offset, short whence,
                    off_t length, PFS_WAIT_LOCK dowait, off_t *start)
```

Arguments:

fp	Open file pointer	
type	Type of lock to set. The following values are defined:	
	F_RDLCK	Read lock (shared).
	F_WRLCK	Write lock (exclusive).
offset	Position to start lock.	
whence	Position from which to measure offset. The following values are defined:	
	SEEK_SET	Offset is relative to the start of the file. The offset should be a positive number.
	SEEK_END	Offset is relative to the end of the file. The offset should be a negative number.
length	Length of range locked. If zero is specified as a length the remainder of the file is locked from the position defined by offset and whence.	
dowait	The following values are defined:	
	PFS_WAIT	Wait for release of existing lock prior to resuming execution.
	PFS_NOWAIT	If any portion of the range is locked, PFS_lock fails.
start	Return position relative to the start of the file where the locked range starts. The pointer may be NULL in which case it is ignored.	

Return values:

PFS_SUCCESS	Lock set
PFS_FAILURE	Invalid parameters or lock conflict

8.45. PFS_lseek

Description:

PFS_lseek positions the current file pointer to the position specified.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_lseek (PFS_FID *fp, off_t offset, int whence)
```

Arguments:

fp	Open file pointer	
offset	Position to set file pointer to, relative to whence argument.	
whence	Position from which to measure offset. The following values are defined:	
	SEEK_SET	Offset is measured from the start of the file.
	SEEK_END	Offset is measured from the end of the file.

Return values:

PFS_SUCCESS	File position changed
PFS_FAILURE	.Invalid parameters

8.46. PFS_mapname
8.47. PFS_fmapname

Description:

PFS_mapname will translate the last member of a given path to the namespace specified. The primary purpose of this function is to supply the Macintosh short name to Macintosh servers.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_mapname (PFS_PATHID *pathid, PFS_NAMESPACE
                        namespace, char *namebuf, int buflen)

PFS_RETVAL PFS_fmapname (PFS_FID *fp, PFS_NAMESPACE
                        namespace, char *namebuf, int buflen)
```

Arguments:

pathid	Resolved pathid structure from PFS_getpathid()
fp	Open file pointer
namespace	Namespace in which translated name is to be returned
namebuf	Buffer in which to return name
buflen	Length of return buffer

Return values:

PFS_SUCCESS	Name translated
PFS_FAILURE	Invalid parameters or buffer too small

8.48. PFS_mkdir

Description:

PFS_mkdir creates a directory. The host owner is set to that specified as well as the access permissions.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_mkdir (PFS_PATHID *pathid, mode_t mode, uid_t uid,
                      gid_t gid, unsigned long *dirid, PFS_USER *user)
```

Arguments:

pathid	Resolved pathid for the directory to be created.
mode	Access permissions to be applied to the directory. See PFS_chmod() for a description of this parameter.
uid	Host user identification for the directory owner.
gid	Host group identification for the directory owner.
dirid	Value is incremented and used as the directory ID unless NULL. If NULL the file system will generate its own internal IDs.
user	Pointer to PFS_USER structure previously obtained with PFS_getuser().

Return values:

PFS_SUCCESS	Directory created
PFS_FAILURE	Invalid parameters

8.49. PFS_mpxclose

Description:

PFS_mpxclose closes the file system file. The PFS file pointers are maintained as if the file was still open. This function allows freeing file descriptors for reuse. If a file which has been multiplex closed is referenced it will be reopened.

[File multiplexing needs to be reviewed.]

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_mpxclose (PFS_FID *fp)
```

Arguments:

fp	Open file pointer

Return values:

PFS_SUCCESS	File is close in the underlying file system
PFS_FAILURE	Invalid parameters

8.50. PFS_needfds

Description:

PFS_needfds will multiplex close open files such that the requested number of file descriptors are available for use.

[File multiplexing needs to be reviewed]

Synopsis:

```
#include <pfs.h>

void PFS_needfds (int count)
```

Arguments:

count	Required number of file descriptors

Return values:

None

8.51. PFS_needinodes

Description:

PFS_needinodes will multiplex close a number of files to attempt to free inodes in the Unix file system. This call has no effect on VMS systems.

Synopsis:

```
#include <pfs.h>

void PFS_needinodes (int timescalled, PFS_OPS *funcptrs)
```

Arguments:

timescalled	Number of times the function has been called attempting to get inodes released. The function will increase the number of files closed on each successive call which increments this counter.
funcptrs	File system function pointers [which file system ??]

Return values:

None

8.52. PFS_open

Description:

PFS_open will open a file stream. The function has the ability memory map the file under Unix. For VMS this option is ignored.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_open (PFS_PATHID *pathid, PFS_STAT *statbufp, int
                     oflag, PFS_DATA_STREAM stream, PFS_MEM_MAP
                     dommap, PFS_FID **fp, PFS_USER *user)
```

Arguments:

pathid	Resolved pathid as returned by PFS_getpathid()
statbufp	Status buffer pointer. If the server has the status buffer for a non primary stream and wishes to open the stream it can save a PFS_stat() call by specifying the buffer.
oflag	Open mode flags. The following bits are defined:

00000 O_RDONLY	Open the file for read access only.
00001 O_WRONLY	Open the file for write access only.
00002 O_RDWR	Open file for both read and write access.
00010 O_APPEND	Open file for append access.
01000 O_CREAT	Create stream if it does not exist
02000 O_TRUNC	Truncate stream if it exists
200000 O_SHARE	Open file for shared access

stream	Specifies the stream to open (or create). Note that the primary stream must already exist.
dommap	Memory map the file. This option has significance under Unix only.
fp	Return open file pointer.
user	Pointer to PFS_USER structure previously obtained with PFS_getuser().

Return values:

PFS_SUCCESS	File open
PFS_FAILURE	Invalid parameters

8.53. PFS_parse *

Description:

PFS_parse returns a structure defining the components of a file path in a specified namespace. This function is intended to remove file system namespace manipulation assumptions from the server. The server should use this function to process components of a path specification. The PFS_NAMEID structure is defined in section 7.5.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_parse (char *path, PFS_NAMESPACE namespace,
                      PFS_NAMEID *nameid)
```

Arguments:

path	File specification
namespace	Namespace in which path exists
nameid	Return structure defining the components of the path.

Return values:

PFS_SUCCESS	Path parsed
PFS_FAILURE	Invalid path

8.54. PFS_pathfunc *

Description:

PFS_pathfunc provides a number of path operations which contain the path specific knowledge to a set of routines. These routines are collectively called a Path Library.

PFS_pathfunc is provided to suppliment the path operations which may be performed directly on the PFS_NAMEID structure. The PFS_NAMEID structure contains the components of the path and may be used directly to extract specific components. Path functions which require additional information or knowledge of the path semantics are provided by PFS_pathfunc().

The PFS_NAMEID structure is defined in section 7.5.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_pathfunc (PFS_NAMEID *nameid, PFS_PATH_CMDS
                        cmd, unsigned p1, unsigned p2, unsigned p3, unsigned
                        p4)
```

Arguments:

nameid	Structure defining the components of the path.
cmd	PFS_PATH_CMD defining the path operation to perform. The following commands are defined:

PFS_PATH_SPLIT

This function will split a path into two components, the path to the object and the object. The object may be a file or directory depending on the path.

p1 - Path buffer
p2 - Path buffer size
p3 - Object buffer
p4 - Object buffer size

PFS_PATH_PARENT

This function will return the parent path of the specified path.

p1 - Parent buffer
p2 - Parent buffer size

PFS_PATH_DIRECTORY

This function will return the path as a directory path. If the path is already a directory path it is returned as is. If the path is a file path it is converted to a directory path using the path semantics of the namespace specified in the PFS_NAMEID structure.

p1 - Directory buffer
p2 - Directory buffer size

PFS_PATH_MATCHNAME
PFS_PATH_MATCHPATH

These two functions compare two PFS_NAMEID structures and return PFS_SUCCESS if the file component match or entire path match, respectively.

p1 - Compare PFS_NAMEID structure

PFS_PATH_MATCHPATTERN

This function will perform a wildcard match using the wildcard rules of the namespace specified in the PFS_NAMEID structure. Only the file component of the PFS_NAMEID structure is compared. The pattern is specified as an ASCIZ string.

p1 - Match pattern

PFS_PATH_MVWILD

This function supports the MSDOS move and rename function. The arguments to the function supply a match pattern, replace pattern and an output buffer. If the file component of the PFS_NAMEID structure matches the match pattern the replace pattern is used to replace characters in the file component. The result is written to the output buffer. If the match fails the function will return PFS_FAILURE.

p1 - Match pattern
p2 - Replace pattern
p3 - Output buffer
p4 - Output buffer size

PFS_PATH_EXPANDNAME

This function expands the file component of the PFS_NAMEID structure to the MSDOS 8.3 blank padded filename format.

p1 - Output buffer
p2 - Output buffer size

p1-p4	Additional arguments required by specific functions. Unused arguments should be specified as NULL.

Return values:

PFS_SUCCESS	Path oeration completed successfully
PFS_FAILURE	Path function failed

8.55. PFS_purge

Description:

PFS_purge deletes a file. The PFS_ATTR no_purge attribute is ignored and the file is deleted.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_purge (PFS_PATHID *pathid, PFS_USER *user)
```

Arguments:

pathid	Resolved pathid as returned by PFS_getpathid().
user	Pointer to PFS_USER structure previously obtained with PFS_getuser().

Return values:

PFS_SUCCESS	File deleted
PFS_FAILURE	Invalid path or no access

8.56. PFS_read

Description:

PFS_read will read data from an open file stream.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_read (PFS_FID *fp, void *buffer, unsigned int nbytes,
                     off_t offset, unsigned int *bytesread)
```

Arguments:

fp	Open file pointer
buffer	Buffer for return data
nbytes	Size of return buffer
offset	Position relative to start of the stream from which to read data.
bytesread	Return count of bytes actually read from the stream.

Return values:

PFS_SUCCESS	Bytes read (including none)
PFS_FAILURE	Invalid parameters

8.57. PFS_readdesc *

Description:

PFS_readesc will read data from an open stream and return a set of mapping pointers describing the data. The data itself remains in the data cache, i.e. the caller is given a pointer to cache buffers.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_readdesc (PFS_FID *fp, unsigned int nbytes, off_t offset,
                         struct buffer_descriptor **desc)
```

Arguments:

fp	Open file pointer.
nbytes	Number of bytes to read.
offset	Offset releative to the start of the stream from which to read.
desc	Pointer to receive data description. [Need specification of work element for data cache].

Return values:

PFS_SUCCESS	Data read
PFS_FAILURE	Invalid parameters

8.58. PFS_releasedesc *

Description:

PFS_releasedesc will release the data associated with the descriptors previously returned by PFS_readdesc().

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_releasedesc (PFS_FID *fp, struct buffer_descriptor
                            **desc)
```

Arguments:

fp	Open file pointer
desc	Descriptor pointer returned by PFS_readdesc().

Return values:

PFS_SUCCESS	Data released
PFS_FAILURE	Invalid parameter

8.59. PFS_rename

Description:

PFS_rename will rename a file or directory. The files MUST both exist in the same file system. The function accepts two pathid structures describing the files to be renamed. These structures will have previously resolved namespace considerations. However, BOTH files must exist in the same namespace.

There are cross namespace implications in renaming a file. The VMS, DOS and Macintosh names are all releated and therefore a change to one will result in a change to all. The mapping is as follows:

Table 8-1: Relationship between namespaces

VMS	DOS	Macintosh
If changed	VMS name	VMS name
DOS name	If changed	DOS name
Short name	Short name	If changed

The table shows the effect of a change in one namespace on the names which will be seen in the other namespaces. The column marked "If changed" indicates the namespace in which a filename change occurred. The remainder of that row shows the effect on the filenames in the other namespaces. For example, if a filename change is made in the DOS namespace, VMS would use the new DOS name as well as Macintosh.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_rename (PFS_PATHID *oldpathid, PFS_PATHID
                       *newpathid, PFS_USER *user)
```

Arguments:

oldpathid	Resolved pathid structure for origninal file name.
newpathid	Resolved pathid structure for new file name.
user	Pointer to PFS_USER structure previously obtained with PFS_getuser().

Return values:

PFS_SUCCESS	File renamed
PFS_FAILURE	Invalid parameters, conflicting file systems or conflicting namespace

8.60. PFS_rmdir

Description:

PFS_rmdir will delete a directory. The directory must be empty.

Synopsis:

#include <pfs.h>

PFS_RETVAL PFS_rmdir (PFS_PATHID *pathid, PFS_USER *user)

Arguments:

pathid	Resolved pathid structure as returned by PFS_getpathid().
user	Pointer to PFS_USER structure previously obtained with PFS_getuser().

Return values:

PFS_SUCCESS	Directory deleted
PFS_FAILURE	Invalid parameter, directory not empty

8.61. PFS_setattr
8.62. PFS_fsetattr

Description:

PFS_setattr sets NOS file atributes. Each member of the PFS_ATTR structure has a corresponding mask bit. Only the attributes indicated by the mask are affected. In this manner, conncurrent update may be handled without additional synchronization. Simultaneous updates to the same fields without external synchronization will not yeild predictable results as the order of individual field updates can not be guaranteed. However, simultaneous updates to different fields will yeild the expected results.

A file must be writeable in order to modify the attributes. If a file is open when the attributes are modified it must be open for write access.

Note that the mask of elements to modify is contained in the attributes structure, not specified separately as in PFS_getattr().

The PFS_ATTR structure is defined in section 7.5.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_setattr (PFS_PATHID *pathid, PFS_ATTR *attrp,
                        PFS_USER *user)

PFS_RETVAL PFS_fsetattr (PFS_FID *fp, PFS_ATTR *attrp)
```

Arguments:

pathid	Resolved pathid structure as returned by PFS_getpathid()
fp	Open file pointer. File must be open for write access.
attrp	Pointer to PFS_ATTR structure containing attributes to modify
user	Pointer to PFS_USER structure previously obtained with PFS_getuser().

Return values:

PFS_SUCCESS	Attributes modified
PFS_FAILURE	Invalid paramters or file not writeable

8.63. PFS_setcomment

Description:

PFS_setcomment will associate a text string with a file. The comment format is as defined for PFS_getcomment().

If a comment is already associated with the file it is replaced.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_setcomment (PFS_PATHID *pathid, char *comment,
                           PFS_USER *user)
```

Arguments:

pathid	Resolved pathid as returned by PFS_getpathid()
comment	Comment block as defined in PFS_getcomment().
user	Pointer to PFS_USER structure previously obtained with PFS_getuser().

Return values:

PFS_SUCCESS	Comment written
PFS_FAILURE	Invalid paramters or file not writeable

8.64. PFS_setcontext

Description:

PFS_setcontext establishes the thread context for PFS functions which use globals for return values. This function establishes the location for PFS_errno, working directory and the mapped host user.

This function must be called on every thread swithc to insure a stalled PFS function is restarted in the proper context.

NOTE

This function is soon to be obsolete.

Synopsis:

```
#include <pfs.h>

void PFS_setcontext (PFS_CONTEXT *context)
```

Arguments:

context	PFS context block containing the host user, PFS_errno and errno pointers and the working directory buffer.

Return values:

None

8.65. PFS_setextattr
8.66. PFS_fsetextattr

Description:

PFS_setextattr sets the extended attributes of a file. The extended attrributes are described in PFS_getaextattr(). The PFS_GEALIST member is ignored on set operations.

The PFS_FEALIST points to an array of extended atrributes blocks, PFS_FEA. Each array member describes one attribute to add, delete or modify.

If the attributes does not exist it is added. If the attribute already exists it is replaced. If the value length field of the attribute is zero, the attribute is deleted.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_setextattr (PFS_PATHID *pathid, PFS_EAOPS *eaopsp,
                           PFS_USER *user)

PFS_RETVAL PFS_setextattr (PFS_FID *fp, PFS_EAOPS *eaopsp)
```

Arguments:

pathid	Resolved pathid structure as returned by PFS_getpathid()
fp	Open file pointer.
eaopsp	Pointer to extended attributes structure. The gealist member of the structure is ignored. The structure is defined in PFS_getextattr().
user	Pointer to PFS_USER structure previously obtained with PFS_getuser().

Return values:

PFS_SCCESS	Attributes modified
PFS_FAILURE	Invalid parameters or file not writeable

8.67. PFS_setlognores

Description:

PFS_setlognores accepts a function pointer to be called when resources are exhausted.

Synopsis:

```
#include <pfs.h>

void PFS_setlognores (void (*func) ())
```

Arguments:

func	Address of routine entry mask. This routine will be called when PFS exhausts resources. Memory, disk space, IO channels, etc will be reported. Note that no arguments are passed to the called function.

Return values:

None

8.68. PFS_setnotifympx

Description:

PFS_setnotifympx accpets a function pointer to be called when file multiplexing occurs.

Synopsis:

```
#include <pfs.h>

void PFS_setnotifympx (void (*func) ())
```

Arguments:

func	Address of routine entry mask. This routine will be called when PFS multiplex closes a file. Note that no arguments are passed to the called function.

Return values:

None

8.69. PFS_setsecurity *
8.70. PFS_fsetsecurity *

Description:

PFS_setsecurity associates NOS security data with a file object. The security data is not interpretted.

For PFS_LMXSECURE the interface is identical to that of PFS_setextattr().

For PFS_MACSECURE the interface accepts a pointer to the "ownerID" member of the Macintosh ACE and writes 11 bytes of data to the file's Macintosh ACE.

If PFS_setsecurity() returns PFS_NOTSUPPORTED the server must be prepared to find alternate storage means for the security data. Not all underlying file systems support association of security data with files.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_setsecurity (PFS_PATHID *pathid, PFS_SECURSPACE
                            securspace, void *securp, PFS_USER *user)

PFS_RETVAL PFS_fsetsecurity (PFS_FID *fp, PFS_SECURSPACE
                             securspace, void *securp)
```

Arguments:

pathid	Resolved pathid structure as returned by PFS_getpathid()	
fp	Open file pointer	
securspace	Security data space to be modified. The following values are defined:	
	PFS_LMXSECURE	Lan Manager security space.
	PFS_MACSECURE	Macintosh security space.
securp	For PFS_LMXSECURE, a pointer to extended attributes structure containing named security data. The semantics are identical to those of PFS_setextattr(). For PFS_MACSECURE a pointer to the "ownerID" member of the Macintosh ACE.	
user	Pointer to PFS_USER structure previously obtained with PFS_getuser().	

Return values:

PFS_SUCCESS	Data associated

PFS_FAILURE	Invalid parameters or file not writeable
PFS_NotSupported	Security data not supported

8.71. PFS_setsecuritymode

Description:

PFS_setsecuritymode sets the global server security mode.

Synopsis:

```
#include <pfs.h>

void PFS_setsecuritymode (PFS_SECURITY_MODE mode)
```

Arguments:

mode	Security mode to establish it may be one of the following:	
	PFS_NOS_SECURITY	Never check host security.
	PFS_CREATOR_SECURITY	Check security if the file was not created by the server.
	PFS_HOST_SECURITY	Always check host security.

Return values:

None

8.72. PFS_setuser

Description:

PFS_setuser is called to establish the global default host user for the process.

Synopsis:

```
#include <pfs.h>

void PFS_setuser (PFS_USER *user)
```

Arguments:

user	Pointer to PFS_USER structure previously obtained with PFS_getuser().

Return values:

None

8.73. PFS_shortpath

Description:

PFS_shortpath sets the shortpath member of the pathid structure relative to the current working directory, if working directories are supported. Not all file systems support this and for those which dont, this function is a NOP.

Synopsis:

```
#include <pfs.h>

void PFS_shortpath (PFS_PATHID *pathid)
```

Arguments:

pathid	Resolved pathid structure as returned by PFS_getpathid()

Return values:

None

8.74. PFS_shutdown

Description:

PFS_shutdown is called to clean up the file system prior to server exit. This function is optional as the file system is responsible for cleanup on process exit.

Synopsis:

```
#include <pfs.h>

void PFS_shutdown (void)
```

Arguments:

None

Return values:

None

8.75. PFS_stat
8.76. PFS_fstat

Description:

PFS_stat will obtain file location information and file structure information for the file containing the given stream. The data structures returned are indended to be opaque. This call is provided for potential performance optimizations in the server. It is expected that the return PFS_STAT structure is to be given back to PFS at some later time, potentially saving multiple stat calls in PFS.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_stat (PFS_PATHID *pathid, PFS_DATA_STREAM
                     stream, unsigned long mask, PFS_STAT *statbufp)

PFS_RETVAL PFS_fstat (PFS_FID *fp, unsigned long mask, PFS_STAT
                      *statbufp)
```

Arguments:

pathid	Resolved pathid structure as returned by PFS_getpathid().
fp	Open file pointer
stream	File stream for which information is to be returned.
mask	Mask of elements to be returned.
statbufp	Pointer to return PFS_STAT structure.

Return values:

PFS_SUCCESS	Information obtained
PFS_FAILURE	Invalid parameters

8.77. PFS_statvfs
8.78. PFS_fstatvfs

Description:

PFS_statvfs provides information about a mounted file system. The function will obtain the amount of free space, total space, cluster size and total number of files allowed on a volume.

NOTE

VMS systems will use the disk quota allocted to a specific user, if such quotas are established.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_statvfs (PFS_PATHID *pathid, statvfs_t *fsbufp,
                        PFS_USER *user)

PFS_RETVAL PFS_fstatvfs (PFS_FID *fp, statvfs_t *fsbufp, PFS_USER
                        *user)
```

Arguments:

pathid	Resolved pathid as returned by PFS_getpathid()
fp	Open file pointer
fsbufp	Return file system information block. This structure is defined for Unix systems only.
user	Pointer to PFS_USER structure previously obtained with PFS_getuser().

Return values:

PFS_SUCCESS	Information obtained
PFS_FAILURE	Invalid parameters

8.79. PFS_sync

Description:

PFS_sync will flush all modified data. All file headers are written out to disk as well as all file data.

Synopsis:

```
#include <pfs.h>

void PFS_sync (void)
```

Arguments:

None

Return values:

None

8.80. PFS_treetop

Description:

PFS_treetop sets the treetop member of the pathid structure to that specified. This field is not used by PFS and is provided for server use.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_treetop (PFS_PATHID *pathid, char *treetop)
```

Arguments:

pathid	Resolved pathid structure as returned by PFS_getpathid()
treetop	Pointer to be copied to treetop member of pathid structure. PFS makes no assumptions about the contents of this pointer.

Return values:

PFS_SUCCESS	Treetop written
PFS_FAILURE	Invalid parameters

8.81. PFS_timefunc

Description:

PFS_timefunc provides operations on time buffers in various formats.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_timefunc (PFS_TIME_CMDS cmd, PFS_TIMESPACE
                        srctimespace, void *srctime, PFS_TIMESPACE
                        dsttimespace, void *dsttime)
```

Arguments:

cmd	Time operation command. The foloowing are currently defined:	
	PFS_TIME_CONVERT	Convert the time from the source format to the destination format.
srctimespace	Source time space. The following time spaces are defined:	
	PFS_UNIXTIME	Unsigned count of seconds since 1-JAN-1970
	PFS_DOSTIME	DOS time structure
	PFS_MACTIME	Signed count of seconds since 1-JAN-2000
	PFS_VMSTIME	Quadword count of 10 nanosecond intervals since 17-NOV-1858
	PFS_TEXTTIME	ASCII representation of time in DD-MMM-YYYY HH:MM:SS.T format
	PFS_NATIVETIME	Platform specific host time
srctime	Source time buffer	
dsttimespace	Desitnation time space. The same time spaces are defined as for srctimespace.	
dsttime	Destination time	

Return values:

PFS_SUCCESS	Time operation complete

PFS_FAILURE	Failure in operation

8.82. PFS_ftruncate

Description:

PFS_truncate will truncate a file at a given offset. This call yeilds the same result as PFS_write() with a zero buffer length.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_ftruncate (PFS_FID *fp, off_t size)
```

Arguments:

fp	Open file pointer
size	Position at which to truncate the file.

Return values:

PFS_SUCCESS	File truncated
PFS_FAILURE	Invalid parameters or file not writeable

8.83. PFS_unlock

Description:

PFS_unlock releases a file system byte range lock established by PFS_lock().

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_unlock (PFS_FID *fp, off_t offset, short whence, off_t
                       length)
```

Arguments:

fp	Open file pointer	
offset	Position at which lock starts	
whence	Position from which to measure offset. The following values are defined:	
	SEEK_SET	Offset is measured from the start of the file. Offset should be a positive number.
	SEEK_END	Offset is measured from the end of the file. Offset should be a negative number.
length	Length of range lock. A value of zero indicates range from offset to the end of the file.	

Return values:

PFS_SUCCESS	Range lock removed
PFS_FAILURE	Invalid parameters or no range locked

8.84. PFS_unmap

Description:

PFS_unmap cleans up a memory mapped file. It does not close the file.

Synopsis:

```
#include <pfs.h>

void PFS_unmap (PFS_FID *fp)
```

Arguments:

fp	Open file pointer which was memory mapped by PFS_open().

Return values:

None

8.85. PFS_utime
8.86. PFS_futime

Description:

PFS_utime sets the file modification time and file access time. The time is specified in Unix time format. This function does not affect the NOS times associated with a file. Use PFS_setattr() for modification of NOS times.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_utime (PFS_PATHID *pathid, struct utimebuf *timebufp,
                      PFS_USER *user)

PFS_RETVAL PFS_utime (PFS_FID *fp, struct utimebuf *timebufp)
```

Arguments:

pathid	Resolved pathid structure as returned by PFS_getpathid().
fp	Open file pointer
timebufp	Time buffer containing two Unix times, the first for access time and the second for modification time.
user	Pointer to PFS_USER structure previously obtained with PFS_getuser().

Return values:

PFS_SUCCESS	Time modified
PFS_FAILURE	Invalid parameters or file not writeable

8.87. PFS_write

Description:

PFS_write will write data to a file. The file must be open for write access.

If nbytes is zero the file is NOT truncated at the current offset, rather it is extended to that position if necessary. If the server is to truncate a file it must use PFS_truncate.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_write (PFS_FID *fp, void *buffer, unsigned int nbytes,
                      off_t offset, unsigned int byteswritten)
```

Arguments:

fp	Open file pointer
buffer	Data buffer to write
nbytes	Size of buffer to write. If this argument is zero the file will be truncated at the position specified by offset.
offset	Position relative to the start of the file at which data is to be written.
byteswritten	Return count of bytes actually written.

Return values:

PFS_SUCCESS	File written
PFS_FAILURE	Invalid parameters or file not open for write.

8.88. PFS_writedesc *

Description:

PFS_writedesc will write data to a file by descriptor reference. The descriptor format is defined in PFS_readdesc(). The server is responsible for creating the descriptors and releasing the storage associated with them.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_writedesc (PFS_FID *fp, off_t offset, struct
                    buffer_descriptor **desc)
```

Arguments:

fp	Open file pointer
offset	Position relative to start of file at which data is to be written.
desc	Descriptior list pointer.

Return values:

PFS_SUCCESS	File written
PFS_FAILURE	Invalid parameters or file not open for write access.

9. FSLIB (File System Library) ROUTINE DESCRIPTIONS

9.1. FSLIB_access *
9.2. FSLIB_faccess *

Description:

See PFS_access().

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_access (PFS_PATHID *pathid, PFS_USER *user,
                         PFS_SECURITY_MODE mode, int perms)

PFS_RETVAL FSLIB_faccess (PFS_FID *fp, PFS_USER *user,
                          PFS_SECURITY_MODE mode, int perms)
```

Arguments:

See PFS_access().

Return values:

PFS_SUCCESS	Access is allowed
PFS_FAILURE	No access or invalid path

9.3. FSLIB_chdir
9.4. FSLIB_fchdir

Description:

See PFS_chdir().

Synopsis:

#include <pfs.h>

PFS_RETVAL FSLIB_chdir (PFS_PATHID *pathid, PFS_USER *user)

PFS_RETVAL FSLIB_fchdir (PFS_FID *fp, PFS_USER *user)

Arguments:

See PFS_chdir().

Return values:

PFS_SUCCESS	Default set
PFS_FAILURE	Invalid pathid or fp

9.5. FSLIB_checksecurity

Description:

See PFS_checksecurity().

Synopsis:

```
#include <pfs.h>

PFS_CHKSTATUS FSLIB_checksecurity (PFS_PATHID *pathid,
                    PFS_SECURSPACE *securspace, PFS_EAOPS
                    *eaopsp, PFS_CHKSTATUS (*rtn)(), unsigned param)

PFS_CHKSTATUS FSLIB_checksecurity (PFS_PATHID *pathid,
                    PFS_SECURSPACE *securspace, PFS_MACSECUR
                    *eaopsp, PFS_CHKSTATUS (*rtn)(), unsigned param)
```

Arguments:

See PFS_checksecurity().

Return values:

PFS_ACCESS	Access allowed
PFS_NOACCESS	Access not allowed
PFS_CHKFAILED	Function failed

9.6. FSLIB_chmod
9.7. FSLIB_fchmod

Description:

See PFS_chmod().

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_chmod (PFS_PATHID *pathid, mode_t mode,
                        PFS_USER *user)

PFS_RETVAL FSLIB_fchmod (PFS_FID *fp, mode_t mode)
```

Arguments:

See PFS_chmod().

Return values:

PFS_SUCCESS	Protection changed
PFS_FAILURE	Invalid path

9.8. FSLIB_chown
9.9. FSLIB_fchown

Description:

See PFS_chown().

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_chown (PFS_PATHID *pathid, uid_t uid, gid_t gid,
                        PFS_USER *user)

PFS_RETVAL FSLIB_fchown (PFS_FID *fp, uid_t uid, gid_t gid)
```

Arguments:

See PFS_chown().

Return values:

PFS_SUCCESS	Owner changed
PFS_FAILURE	Invalid path

9.10. FSLIB_claim

Description:

FSLIB_claim determines if the given path is in the current file system. The function may store one longword in the pathid structure cp member for future use.

Synopsis:

```
#include <pfs.h>

PFS_FSTATUS FSLIB_claim (PFS_PATHID *pathid, char *path,
                         PFS_NAMESPACE namespace)
```

Arguments:

pathid	Partially resolved pathid structure. This structure will contain the root name in the fullpath member. The file system should use this and possibly the client path name to determine if it owns the path.
path	Client path.
namespace	Namespace in which path resides.

Return values:

PFS_EXISTS	File exists and is claimed by this library
PFS_NOEXIST	File does not exist but the parent path does and is claimed by this library.
PFS_UNCLAIMED_EXISTS	File exists but this library does not support it
PFS_UNCLAIMED_NOEXIST	File does not exist but the parent does. It is not supported by this library.
PFS_FAILED	Neither the file nor the parent exist in this library.

9.11. FSLIB_close

Description:

See PFS_close().

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_close (PFS_FID *fp)
```

Arguments:

See PFS_close().

Return values:

PFS_SUCCESS	File closed
PFS_FAILURE	Invalid file pointer

9.12. FSLIB_closedesc

Description:

FSLIB_closedesc() closes the open file associated with the data cache. File system libraries are free to chose how to handle this close function (denpeding on how they opened the file for data cache access). This function is called AFTER the main file has been closed. However, file systems are free to keep the main file open until FSLIB_closedesc() is called.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_closedesc (void *fd)
```

Arguments:

fd	Pointer assigned by FSLIB_opendesc()

Return values:

PFS_SUCCESS	File closed
PFS_FAILURE	Invalid file pointer

9.13. FSLIB_convert *

Description:

FSLIB_convert translates a filename from NOS format to native format. This function is used by PFS_getpathid() to resolve filenames prior to file lookup. If the file system does not require name translation this function should simply return PFS_SUCCESS.

The root directory is assumed to be located in the fullpath member of the pathid structure.

The resultant filename is returned in fullpath member of the pathid structure.

FSLIB_convert is expected to convert the client name to a native name. This may involve file system lookups. The function should set the apropriate fields in the pathid such that FSLIB_lookup can determine that lookups have already been done.

FSLIB_convert is expected to convert all members of a path with the exception of the last member. This member may not exist (creates) and may be stored in pathid.client_name for future use. The function should set the appropriate fields in the pathid structure such that FSLIB_lookup can determine the file does not exist.

As can be seen FSLIB_convert and FSLIB_lookup are designed to work together to process a file path. The partition of functions is left to the library implementation. However, FSLIB_lookup must be given sufficient information to determine if a path exists and if the path's parent exists.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_convert (PFS_PATHID *pathid, char *path,
                          PFS_NAMESPACE namespace)
```

Arguments:

pathid	Resolved pathid structure as returned by PFS_getpathid()
path	Client file path
namespace	Namespace in which path resides.

Return values:

PFS_SUCCESS	Name translated
PFS_FAILURE	Invalid parameters

9.14. FSLIB_create *

Description:

See PFS_create().

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_create (PFS_PATHID *pathid, mode_t mode, uid_t uid,
                         gid_t gid, PFS_CREATE_TYPE type, PFS_FID **fp,
                         PFS_USER *user)
```

Arguments:

See PFS_create().

Return values:

PFS_SUCCESS	File created
PFS_FAILURE	Invalid path or file exists and PFS_MAKENEW specified

9.15. FSLIB_dentpathid *

Description:

See PFS_dentpathid().

Synopsis:

```
#include <pfs.h>
#include <dirent.h>

PFS_FSTATUS FSLIB_dentpathid (PFS_FID *fp, struct dirent *dirent,
                              PFS_PATHID *pathid)
```

Arguments:

See PFS_dentathid().

Return values:

PFS_EXISTS	Path exists as specified.
PFS_NOEXIST	Path does not exist but the parent path does (i.e. a new file specification).
PFS_FAILED	Neither parent nor path exists or insuffiecient information to locate the path.

9.16. FSLIB_didpathid *

Description:

See PFS_didpathid().

Synopsis:

```
#include <pfs.h>

PFS_FSTATUS FSLIB_didpathid (PFS_CWD *dirid, char *path,
                    PFS_NAMESPACE namespace, PFS_PATHID *pathid)
```

Arguments:

See PFS_didpathid().

Return values:

PFS_EXISTS	Path exists as specified.
PFS_NOEXIST	Path does not exist but the parent path does (i.e. a new file specification).
PFS_FAILED	Neither parent nor path exists.

9.17. FSLIB_diridfunc

Description:

See PFS_diridfunc().

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_diridfunc (PFS_DIRID_CMD cmd, char *root,
                            unsigned long dirid, PFS_CWD *dirptr)
```

Arguments:

See PFS_diridfunc().

Return values:

PFS_SUCCESS	Directory ID translated
PFS_FAILURE	Invalid directory ID or no directory ID set open.

9.18. FSLIB_diridinit

Description:

See PFS_diridinit().

Synopsis:

```
#include <pfs.h>

void FSLIB_diridinit (PFS_DIRIDS_MATTER dodirids, unsigned long
                      *diridptr)
```

Arguments:

See PFS_diridinit().

Return values:

None

9.19. FSLIB_fextend

Description:

FSLIB_fextend() is called to extend the allocated blocks in a file. This call is only used when PFS is caching data above the file system. Note that the file system may be called to position a file at an offset which has not yet been written due to write back caching. This call notifies the file system of writes to the file.

PFS caches data independent of disk allocation, quotas or any such limitations. It is the responsibility of the file system to determine if the caller has the requisite disk allocation necessary to satisfy the pending write.

NOTE

PFS does not keep track of end-of-file. Therefore it is not possible for PFS to determine if an extension is required and only call this function if so. Therefore, this function is called for every write to the file. It is the responsibility of the file system to keep track of end-of-file and extend the file if the position specified in this call exceeds the end-of-file (or more precisely, the blocks allocated to the file).

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_fextend (PFS_FID *fp, off_t offset, PFS_USER *user)
```

Arguments:

fp	Open file pointer.
offset	File position at end of pending write.
user	Current host user associated with pending write.

Return values:

PFS_SUCCESS	File extended or extension allowed
PFS_FAILURE	File not extended or extension not allowed

9.20. FSLIB_filesize
9.21. FSLIB_ffilesize

Description:

See PFS_ffilesize().

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_filesize (PFS_PAHID *pathid, PFS_DATA_STREAM
                           stream, off_t *size, PFS_USER *user)

PFS_RETVAL FSLIB_ffilesize (PFS_FID *fp, off_t *size)
```

Arguments:

See PFS_ffilesize().

Return values:

PFS_SUCCESS	Return size is valid
PFS_FAILURE	Invalid file pointer

9.22. FSLIB_fsync

Description:

See PFS_fsync().

Synopsis:

#include <pfs.h>

PFS_RETVAL FSLIB_fsync (PFS_FID *fp)

Arguments:

See PFS_fsync().

Return values:

PFS_SUCCESS	File flushed
PFS_FAILURE	Invalid file pointer

9.23. FSLIB_getattr
9.24. FSLIB_fgetattr

Description:

See PFS_getattr().

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_getattr (PFS_PATHID *pathid, unsigned long mask,
                          PFS_ATTR *attrp, PFS_USER *user)

PFS_RETVAL FSLIB_fgetattr (PFS_FID *fp, unsigned long mask,
                           PFS_ATTR *attrp)
```

Arguments:

See PFS_getattr().

Return values:

PFS_SUCCESS	Attributes updated
PFS_FAILURE	Invalid parameters

9.25. FSLIB_getcomment

Description:

See PFS_getcomment().

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_getcomment (PFS_PATHID *pathid, char *comment,
                             int buflen, PFS_USER *user)
```

Arguments:

See PFS_getcomment().

Return values:

PFS_SUCCESS	Coment returned
PFS_FAILURE	Invalid parameters

9.26. FSLIB_getdents

Description:

See PFS_getdents().

Synopsis:

```
#include <pfs.h>
#include <dirent.h>

PFS_RETVAL FSLIB_getdents (PFS_FID *fp, struct dirent *direntp, unsigned
                           int nbytes, off_t *offset, PFS_NAMESPACE
                           namespace, unsigned int bytesread)
```

Arguments:

See PFS_getdents().

Return values:

PFS_SUCCESS	Buffer written (including no entries)
PFS_FALURE	Invalid parameters

9.27. FSLIB_getextattr *
9.28. FSLIB_fgetextattr *

Description:

See PFS_getextattr().

This is an optional function. If the library does not support extended attributes the corresponding bit in the PFS_LIB_ENT structure should be clear and this routine need not be present. However, the dispatch vector should point to a routine which will return a failure status.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_getextattr (PFS_PATHID *pathid, PFS_EAOPS
                             *eaopsp, PFS_USER *user)

PFS_RETVAL FSLIB_fgetextattr (PFS_FID *fp, PFS_EAOPS *eaopsp)
```

Arguments:

See PFS_getextattr().

Return values:

PFS_SUCCESS	Extended attributes written to buffer
PFS_FAILURE	Invalid parameters

9.29. FSLIB_getprintident *

Description:

FSLIB_getprintident returns file identification information in the PFS_IDENT structure. This structure is used primarity by the print subsystem to identify a file.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_getprintident (PFS_PATHID *pathid, PFS_IDENT
                                *identp)
```

Arguments:

pathid	Resolved pathid structure as returned by PFS_getpathid().
identp	Pointer to return identification structure.

Returns:

PFS_SUCCESS	Print identification returned
PFS_FAILURE	Insufficient information

9.30. FSLIB_getsecurity *
9.31. FSLIB_fgetsecurity *

Description:

See PFS_getsecurity().

This is an optional function. If the library does not support security data the corresponding bit in the PFS_LIB_ENT structure should be clear and this routine need not be present. However, the dispatch vector should point to a routine which return a failure status.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_getsecurity (PFS_PATHID *pathid, PFS_SECURSPACE
                        securspace, void *securp, PFS_USER *user)

PFS_RETVAL FSLIB_fgetsecurity (PFS_FID *fp, PFS_SECURSPACE
                        securspace, void *securp)
```

Arguments:

See PFS_getsecurity().

Return values:

PFS_SUCCESS	Returned attributes
PFS_FAILURE	Invalid parameters

9.32. FSLIB_init

Description:

FSLIB_init initializes the file system library. The routine is called once, when the file system is loaded. This routine should be given a universal name of the form <name>_init where <name> is the name of the file system if the library is to be dynamically loaded.

See PFS_init() for a description of dynamic library loading.

Synopsis:

```
#include <pfs.h>

PFS_FSTATUS FSLIB_init (PFS_LIB_ENT *libentp, FILE *log_file)
```

Arguments:

libentp	Pointer to next library entry slot.
log_file	File pointer for debug use. This may be a temporary debug aid for product qualification.

Return values:

None

9.33. FSLIB_lock

Description:

See PFS_lock().

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_lock (PFS_FID *fp, short type, off_t offset, short
                      whence, off_t length, PFS_WAIT_LOCK dowait, off_t
                      *start)
```

Arguments:

See PFS_lock().

Return values:

PFS_SUCCESS	Lock set
PFS_FAILURE	Invalid parameters or lock conflict

9.34. FSLIB_lookup *

Description:

FSLIB_lookup will locate the file in the current file system. The file is located with information left in the pathid structure by FSLIB_convert. The function must determine if a path exists and if not whether the parent exists.

Further, the function must set the PFS_ST_FID flag if a path exists. This flag is used by PFS to determine if a pathid structure points to an existing file. This field must be set even if the FID field is not supported by the file system.

The function must set the PFS_ST_DID flag if the parent path exists. This flag is used by PFS to determine if the parent path exists. This flag must be set even if the file system does not support the DID field.

Synopsis:

```
#include <pfs.h>

PFS_FSTATUS FSLIB_lookup (PFS_PATHID *pathid, char *client_name)
```

Arguments:

pathid	Resolved pathid structure as returned by PFS_getpathid().
client_name	Specified a client name to translate by lookup. This is used for the Macintosh filename translation algorithm.

Return values:

PFS_EXISTS	File located
PFS_NOEXIST	File not found, parent exists
PFS_FAILED	File not found, parent not found

9.35. FSLIB_lseek

Description:

See PFS_lseek().

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_lseek (PFS_FID *fp, off_t offset, int whence)
```

Arguments:

See PFS_lseek().

Return values:

PFS_SUCCESS	File position changed
PFS_FAILURE	Invalid parameters

9.36. FSLIB_mapname
9.37. FSLIB_fmapname

Description:

See PFS_mapname().

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_mapname (PFS_PATHID *pathid, PFS_NAMESPACE
                          namespace, char *namebuf, int buflen)

PFS_RETVAL FSLIB_fmapname (PFS_FID *fp, PFS_NAMESPACE
                          namespace, char *namebuf, int buflen)
```

Arguments:

See PFS_mapname().

Return values:

PFS_SUCCESS	Name translated
PFS_FAILURE	Invalid parameters or buffer too small

9.38. FSLIB_mkdir

Description:

See PFS_mkdir().

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_mkdir (PFS_PATHID *pathid, mode_t mode, uid_t uid,
                        gid_t gid, unsigned long *dirid, PFS_USER *user)
```

Arguments:

See PFS_mkdir().

Return values:

PFS_SUCCESS	Directory created
PFS_FAILURE	Invalid parameters

9.39. FSLIB_mpxclose

Description:

See PFS_mpxclose().

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_mpxclose (PFS_FID *fp)
```

Arguments:

See PFS_mpxclose().

Return values:

PFS_SUCCESS	File is close in the underlying file system
PFS_FAILURE	Invalid parameters

9.40. FSLIB_mpxopen

Description:

FSLIB_mpxopen will multiplex open a file previously multiplex closed. The open mode is stored in the PFS_FID structure and will be used to reopen the file in the same mode as previously open. Note that a file with locks can not be multiplex closed. This eliminates the need to attempt to reestablish lcoks within the file.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_mpxopen (PFS_FID *fp)
```

Arguments:

fp	Previously open file pointer. The file will be reopened in the same mode as originally open.

Return values:

PFS_SUCCESS	File open
PFS_FAILURE	Invalid parameters

9.41. FSLIB_open

Description:

See PFS_open().

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_open (PFS_PATHID *pathid, PFS_STAT *statbufp, int
                       oflag, PFS_DATA_STREAM stream, PFS_MEM_MAP
                       dommap, PFS_FID **fp, PFS_USER *user)
```

Arguments:

See PFS_open().

Return values:

PFS_SUCCESS	File open
PFS_FAILURE	Invalid parameters

9.42. FSLIB_opendesc

Description:

FSLIB_opendesc() opens a file for access by the global data cache. A file system may decide to use separate file pointers for the main file open and the data cache or may use the same file pointer. The global data cache uses a SINGLE file pointer for all access to a given file, regardless of how many times the file is actually open. The file pointer the cache will use is determined by this function.

PFS_open() will call the FSLIB_open() function to open a file or map into an existing open. Following a successful open PFS will call the FSLIB_opendesc() function. This function will determine if the file is to be cached and if so, will return a file pointer to be used by the data cache. This file pointer is passed to FSLIB_readdesc() and FSLIB_writedesc().

PFS_close() will call FSLIB_close() to close the file. After a successful close PFS_close() will call FSLIB_closedesc() IF this is the only open reference in the data cache.

The file system library is free to determine how it wishes to handle distributed file access, either thru the global data cache or on its own. However, PFS assumes that all files may be accessed in a distributed fashion and will freely do so.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_opendesc (PFS_FID *fp, void **fd)
```

Arguments:

fp	Open file pointer
fd	Return file system specific file pointer

Return values:

PFS_SUCCESS	File open
PFS_FAILURE	Data cache access not allowed

9.43. FSLIB_purge
9.44. FSLIB_fpurge

Description:

See PFS_purge().

Note that PFS_fpurge is provided to support PFS_closeandpurge. The file pointer points to a closed file but the file pointer is still valid. Information in the file pointer should be used to guarantee the exact file opened will be deleted (care must be taken if the file is to be deleted by name as multiple versions and search paths may cause the name to be ambiguous). The file system library should provide some means to uniquely identify a file and store this information in the pathid/fid structure.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_purge (PFS_PATHID *pathid, PFS_USER *user)

PFS_RETVAL FSLIB_fpurge (PFS_FID *fp)
```

Arguments:

See PFS_purge().

Return values:

PFS_SUCCESS	File deleted
PFS_FAILURE	Invalid parameters

9.45. FSLIB_read

Description:

See PFS_read().

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_read (PFS_FID *fp, void *buffer, unsigned int nbytes,
                       off_t offset, unsigned int *bytesread)
```

Arguments:

See PFS_read().

Return values:

PFS_SUCCESS	Bytes read (including none)
PFS_FAILURE	Invalid parameters

9.46. FSLIB_readdesc *

Description:

FSLIB_readdesc() is called to read a portion of the specified file into the specified descriptor list. The file system should fill the descriptors in the order specified in the descriptor list and must fill complete buffers before proceeding to the next descriptor.

Figure 9-1: Format of a Buffer Descriptor

BDSC_A_LINK		0
BDSC_L_BCNT		4
BDSC_A_BUFFER		8
BDSC_L_OFFSET		12
BDSC_W_VALIDBYTES	BDSC_R_FLAGS	16
BDSC_A_PCSSTATE		20
BDSC_A_PCSSTATESVA		24
BDSC_A_BUFFERSVA		28

Table 9-1: Contents of a Buffer Descriptor

Field Name	Description
BDSC_A_LINK	Pointer to next buffer descriptor in list. a NULL link indicates the end of the list.
BDSC_L_BCNT	Count of bytes in the data buffer.
BDSC_A_BUFFER	Address of the data buffer.
BDSC_L_OFFSET	File offset for start of the data buffer.
BDSC_R_FLAGS	Buffer flags. The following flags are defined: BDSC_M_MODIFY_INTENT BDSC_M_NO_PREFILL
BDSC_W_VALIDBYTES	Return count of validbytes for read functions.
BDSC_A_PCSSTATE	PCS state longword. This field is private to PCS.
BDSC_A_PCSSTATESVA	System virtual address of the PCS state buffer. This field is private to PCS.
BDSC_A_BUFFERSVA	System virtual address of the data buffer.

The buffer descriptor contains the address of the next descriptor or NULL in the bdsc_a_link member. The FSLIB_readdesc() function should use this pointer to process the buffer list.

The bdsc_l_bcnt member specifies the size of the buffer to be filled by the file system. This buffer is completely filled, up to end of file. The amount of data written to the buffer is set by the file system in the bdsc_w_validbytes member. If this field is less than the initial buffer size all remaining buffers in the list should have zero valid bytes.

NOTE

The flag bdsc_v_modify_intent (contained in the bdsc_r_flags member) specifies that this read is a back fill of a buffer about to be modified. The file system may use this flag to optimize filling the buffer with only data which is not in the modify region (specified by the nbytes and offset parameters to the function). Note that the bdsc_w_validbytes member must reflect the modify range in the buffer as well as any data actually written to the buffer. This optimization is not required but is suggested.

The bdsc_l_offset member specifies the position in the file represented by the start of this buffer. The position is specified as a zero based byte count relative to the start of the file.

The remainder of the structure is private to the cluster cache manager.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_readdesc (void *fd, unsigned int nbytes, off_t offset,
                           PFS_DESC *desc)
```

Arguments:

fd	File pointer as returned by FSLIB_opendesc()
nbytes	Number of bytes in modify region or client requested read range.
offset	Starting offset of modify range or client requested read range.
desc	Pointer to first descriptor.

Return values:

PFS_SUCCESS	Data read
PFS_FAILURE	Invalid parameters

9.47. FSLIB_rename

Description:

See PFS_rename().

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_rename (PFS_PATHID *oldpathid, PFS_PATHID
                         *newpathid, PFS_USER *user)
```

Arguments:

See PFS_rename().

Return values:

PFS_SUCCESS	File renamed
PFS_FAILURE	Invalid parameters, conflicting file systems or conflicting namespace

9.48. FSLIB_rmdir

Description:

See PFS_rmdir().

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_rmdir (PFS_PATHID *pathid, PFS_USER *user)
```

Arguments:

See PFS_rmdir().

Return values:

PFS_SUCCESS	Directory deleted
PFS_FAILURE	Invalid parameter, directory not empty

9.49. FSLIB_setattr
9.50. FSLIB_fsetattr

Description:

See PFS_setattr().

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_setattr (PFS_PATHID *pathid, PFS_ATTR *attrp,
                          PFS_USER *user)

PFS_RETVAL FSLIB_fsetattr (PFS_FID *fp, PFS_ATTR *attrp)
```

Arguments:

See PFS_setattr().

Return values:

PFS_SUCCESS	Attributes modified
PFS_FAILURE	Invalid paramters or file not writeable

9.51. FSLIB_setcomment

Description:

See PFS_setcomment().

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_setcomment (PFS_PATHID *pathid, char *comment,
                             PFS_USER *user)
```

Arguments:

See PFS_setcomment().

Return values:

PFS_SUCCESS	Comment written
PFS_FAILURE	Invalid paramters or file not writeable

9.52. FSLIB_setextattr *
9.53. FSLIB_fsetextattr *

Description:

See PFS_setextattr().

For a description of optional functions see FSLIB_getextattr().

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_setextattr (PFS_PATHID *pathid, PFS_EAOPS
                             *eaopsp, PFS_USER *user)

PFS_RETVAL FSLIB_setextattr (PFS_FID *fp, PFS_EAOPS *eaopsp)
```

Arguments:

See PFS_setextattr().

Return values:

PFS_SUCCESS	Attributes modified
PFS_FAILURE	Invalid parameters or file not writeable

9.54. FSLIB_setsecurity *
9.55. FSLIB_fsetsecurity *

Description:

See PFS_setsecurity().

For a description of optional functions see FSLIB_getsecurity().

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_setsecurity (PFS_PATHID *pathid,
                        PFS_SECURSPACE securspace, void *securp,
                        PFS_USER *user)

PFS_RETVAL FSLIB_fsetsecurity (PFS_FID *fp, PFS_SECURSPACE
                        securspace, void *securp)
```

Arguments:

See PFS_setsecurity().

Return values:

PFS_SUCCESS	Data associated
PFS_FAILURE	Invalid parameters or file not writeable
PFS_NotSupported	Security data not supported

9.56. FSLIB_stat
9.57. FSLIB_fstat

Description:

See PFS_stat().

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_stat (PFS_PATHID *pathid, PFS_DATA_STREAM
                    stream, unsigned long mask, PFS_STAT *statbufp)

PFS_RETVAL FSLIB_fstat (PFS_FID *fp, unsigned long mask, PFS_STAT
                    *statbufp)
```

Arguments:

See PFS_stat().

Return values:

PFS_SUCCESS	Information obtained
PFS_FAILURE	Invalid parameters

9.58. FSLIB_statvfs
9.59. FSLIB_fstatvfs

Description:

See PFS_statvfs().

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_statvfs (PFS_PATHID *pathid, statvfs_t *fsbufp,
                          PFS_USER *user)

PFS_RETVAL FSLIB_fstatvfs (PFS_FID *fp, statvfs_t *fsbufp, PFS_USER
                          *user)
```

Arguments:

See PFS_statvfs().

Return values:

PFS_SUCCESS	Information obtained
PFS_FAILURE	Invalid parameters

9.60. FSLIB_sync

Description:

See PFS_sync().

Synopsis:

```
#include <pfs.h>

void FSLIB_sync (void)
```

Arguments:

None

Return values:

None

9.61. FSLIB_ftruncate

Description:

See PFS_ftruncate().

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_ftruncate (PFS_FID *fp, off_t size)
```

Arguments:

See PFS_ftruncate().

Return values:

PFS_SUCCESS	File truncated
PFS_FAILURE	Invalid parameters or file not writeable

9.62. FSLIB_unlock

Description:

See PFS_unlock().

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_unlock (PFS_FID *fp, off_t offset, short whence, off_t
                          length)
```

Arguments:

See PFS_unlock().

Return values:

PFS_SUCCESS	Range lock removed
PFS_FAILURE	Invalid parameters or no range locked

9.63. FSLIB_unmap

Description:

See PFS_unmap().

Synopsis:

```
#include <pfs.h>

void FSLIB_unmap (PFS_FID *fp)
```

Arguments:

See PFS_unmap().

Return values:

None

9.64. FSLIB_utime
9.65. FSLIB_futime

Description:

See PFS_utime().

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_utime (PFS_PATHID *pathid, void *timebufp,
                        PFS_USER *user)

PFS_RETVAL FSLIB_utime (PFS_FID *fp, void *timebufp)
```

Arguments:

See PFS_utime().

Return values:

PFS_SUCCESS	Time modified
PFS_FAILURE	Invalid parameters or file not writeable

9.66. FSLIB_write

Description:

See PFS_write().

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_write (PFS_FID *fp, void *buffer, unsigned int nbytes,
                        off_t offset, unsigned int byteswritten)
```

Arguments:

See PFS_write().

Return values:

PFS_SUCCESS	File written
PFS_FAILURE	Invalid parameters or file not open for write.

9.67. FSLIB_writedesc *

Description:

FSLIB_writedesc() write bytes to an open file. The write buffer(s) are specified by a descriptor list. (See FSLIB_readesc() for a description).

Synopsis:

```
#include <pfs.h>

PFS_RETVAL FSLIB_writedesc (void *fd, PFS_DESC *desc)
```

Arguments:

fd	Open file pointer as returned by FSLIB_opendesc().
desc	Pointer to first buffer descriptor to be written

Return values:

PFS_SUCCESS	File written
PFS_FAILURE	Invalid parameters or file not open for write access.

10 PATHLIB (Path Library) ROUTINE DESCRIPTIONS

10.1 PATHLIB_parse

Description:

PATHLIB_parse will parse the supplied name and fill out the PFS_NAMEID structure. The function uses the semantics of the library's namespace to break the path into its components. This is the only function which is allowed to modify the PFS_NAMEID structure.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PATHLIB_parse (char *name, PFS_NAMESPACE namespace,
                          PFS_NAMEID *nameid)
```

Arguments:

name	ASCIZ buffer containing the path to be parsed.
namespace	Namespace in wich to parse
nameid	Pointer to a PFS_NAMEID structure to initialize.

Return values:

PFS_SUCCESS	Path parsed
PFS_FAILURE	Invalid path

10.2 PATHLIB_split

Description:

PATHLIB_split uses the PFS_NAMEID structure associated with a path to break the path into directory and file components. The supplied buffers for the directory and file will be written based on the parsed name. PATHLIB_parse will have been called prior to this function.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PATHLIB_split (PFS_NAMEID *nameid, char *dirbuf, int
                    dirbuflen, char *filbuf, int filbuflen)
```

Arguments:

nameid	PFS_NAMEID structure defining path.
dirbuf	Buffer to receive directory component.
dirbuflen	Length of directory buffer.
filbuf	Buffer to receive file component.
filbuflen	Length of file buffer.

Return values:

PFS_SUCCESS	Path split
PFS_FAILURE	Invalid path

10.3 PATHLIB_parent

Description:

PATHLIB_parent will use the PFS_NAMEID structure supplied to obtain the parent of a given path. The parent is the directory which contains the path. For most namespaces the parent path is a subset of the full path. However, for VMS the parent may be the root directory, [000000], which is not contained in the specified path.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_parent (PFS_NAMEID *nameid, char *parent, int
                        parentlen)
```

Arguments:

nameid	PFS_NAMEID structure for the path for which to obtain the parent.
parent	Buffer to receive the parent path.
parentlen	Length of the parent buffer.

Return values:

PFS_SUCCESS	Parent obtained
PFS_FAILURE	Invalid path

10.4 PATHLIB_directory

Description:

PATHLIB_directory will convert the specified file path to its equivalent directory path.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_directory (PFS_NAMEID *nameid, char *dirbuf, int
                          dirbuflen)
```

Arguments:

nameid	PFS_NAMEID structure for the path to convert to a directory.
dirbuf	Buffer to receive the directory path.
dirbuflen	Length of the directory buffer.

Return values:

PFS_SUCCESS	Directory obtained
PFS_FAILURE	Invalid path

10.5 PATHLIB_matchpath

Description:

PATHLIB_matchpath will compare two full paths and return PFS_SUCCESS if they are identical. The whole path is compared.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PATHLIB_matchpath (PFS_NAMEID *srcpath, PFS_NAMEID
                              *matchpath)
```

Arguments:

srcpath	PFS_NAMEID for the source path to compare.
matchpath	PFS_NAMEID for the compare path.

Return values:

PFS_SUCCESS	Paths are identical
PFS_FAILURE	Invalid path or not identical

10.6 PATHLIB_matchname

Description:

PATHLIB_matchname will compare the file components of two paths and return PFS_SUCCESS if they are identical.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PATHLIB_matchname (PFS_NAMEID *srcpath,
                              PFS_NAMEID *matchpath)
```

Arguments:

srcpath	PFS_NAMEID for the path whose file component is to be matched.
matchpath	PFS_NAMEID for the path whose file component is to be compared.

Return values:

PFS_SUCCESS	File components are identical
PFS_FAILURE	Invalid path or file components not identical.

10.7 PATHLIB_matchpattern

Description:

PATHLIB_matchpattern will compare the file component of the specified path against a wilcard pattern string. The wildcard match rules are namespace specified as are the wildcard characters.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PATHLIB_matchpattern (PFS_NAMEID *srcpath, char
                                 *pattern)
```

Arguments:

srcpath	PFS_NAMEID for the path whose file component is to be matched.
pattern	ASCIZ pattern possibly containing wildcard characters to be used for matching. The match rules are namespace specific as are the characters allowed in the pattern.

Return values:

PFS_SUCCESS	Path match
PFS_FAILURE	Invalid path or no match

10.8 PATHLIB_expandname

Description:

PATHLIB_expandname will expand the file component of a path into its 8.3 blank padded format. This function is useful only in PFS_DOSNAME namespace.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PFS_expandname (PFS_NAMEID *nameid, char *buffer, int
                           buflen)
```

Arguments:

nameid	PFS_NAMEID for path whose file component is to be expanded.
buffer	Buffer to receive the expanded name.
buflen	Length of the supplied buffer.

Return values:

PFS_SUCCESS	Name expanded
PFS_FAILURE	Invalid path or buffer too small

10.9 PATHLIB_mvwild

Description:

PATHLIB_mvwild is used to match a file component and replace specified characters in the file component. The pattern supplied has the same format as for PATHLIB_matchpattern. The match function is identical to PATHLIB_matchpattern.
The replacement function will select the character from the source file component if a wildcard is specified in the replace pattern. If a non wild character is specified in the replace pattern it will be inserted in the corrosponding position in the result file buffer.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL PATHLIB_mvwild (PFS_NAMEID *nameid, char *matchpat,
                           char *replacepat, char *buffer, int buflen)
```

Arguments:

nameid	PFS_NAMEID for path whose file component is to be modified.
matchpat	Match pattern. If the file component does not match this pattern the function will fail.
replacepat	Replace pattern. The pattern specifies which characters to copy from the source file component and which to copy from the pattern. The format of the pattern is namespace specific.
buffer	Buffer to receive modified file component.
buflen	Length of supplied buffer.

Return values:

PFS_SUCCESS	Matched and replaced
PFS_FAILURE	Invalid path or no match

11 TIMELIB (Time Library) ROUTINE DESCRIPTIONS

Time libraries are provided to handle conversion from one time space to another. The time libraries may provide direct conversion routines for each time space, however, only the TIMELIB_fromnativetime() and TIMELIB_tonativetime() function must be provided. If a library does not support direct conversion the associated vector should be specified as NULL.

To perform a conversion from one time space to another PFS will locate the source time space's function dispatch vector and check to see if direct conversions are supported. If so the function is dispatched to handle the conversion. If the library does not support direct conversion PFS will use the library's TIMELIB_tonativetime() function to convert to native time. PFS will then locate the destination time space's library function dispatch table and use the TIMELIB_fromnativetime() function to convert to the destination time space.

11.1 TIMELIB_fromnativetime

Description:

TIMELIB_fromnativetime will convert a native time format to the library's time space format. The native time format is platform specific. It is currently implemented as VMS quadword format.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL TIMELIB_fromnativetime(void *nativetime, void *time)
```

Arguments:

nativetime	Pointer to time buffer in native time format
time	Pointer to buffer to receive library's time format

Return values:

PFS_SUCCESS	Converted
PFS_FAILURE	Invalid time

11.2 TIMELIB_tonativetime

Description:

TIMELIB_tonativetime will convert the library's time space to native time format. Native time format is platform specific. It is currently implemented VMS quadword time.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL TIMELIB_tonativetime (void *time, void *nativetime)
```

Arguments:

time	Pointer to time buffer in library's time format
nativetime	Pointer to buffer to receive native time format

Return values:

PFS_SUCCESS	Converted
PFS_FAILURE	Invalid time

11.3 TIMELIB_tounixtime

Description:

TIMELIB_tounixtime will convert from the library's time format to Unix time format (seconds since 1-JAN-1970). This function is optional. If not supported it should be specified as NULL in the library's function dispatch vector.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL TIMELIB_tounixtime (void *time, void *unixtime)
```

Arguments:

time	Pointer to time buffer in library's time format
unixtime	Pointer to buffer to receive Unix time format

Return values:

PFS_SUCCESS	Converted
PFS_FAILURE	Invalid time

11.4 TIMELIB_todostime

Description:

TIMELIB_todostime will convert from the library's time format to MSDOS time format. MSDOS time format is a 32 bit structure in the following format:

Figure 11-1: Format of DOS Time Buffer

31 27	26 21	20 16	15 9	8 5	4 0
Hour	Minute	Second	Year	Month	Day

MSDOS Time Format

MSDOS time resolution is 2 second intervals and covers the range from 1-JAN-1980 to 31-DEC-2107.

This function is optional. If not supported it should be specified as NULL in the library's function dispatch vector.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL TIMELIB_todostime (void *time, void *dostime)
```

Arguments:

time	Pointer to time buffer in library's time format
dostime	Pointer to buffer to receive MSDOS time format

Return values:

PFS_SUCCESS	Converted
PFS_FAILURE	Invalid time

11.5 TIMELIB_tomactime

Description:

TIMELIB_tomactime will convert from the library's time format to Macintosh time format (signed seconds since 1-JAN-2000). This function is optional. If not supported it should be specified as NULL in the library's function dispatch vector.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL TIMELIB_tomactime (void *time, void *mactime)
```

Arguments:

time	Pointer to time buffer in library's time format
mactime	Pointer to buffer to receive Macintosh time format

Return values:

PFS_SUCCESS	Converted
PFS_FAILURE	Invalid time

11.6 TIMELIB_tovmstime

Description:

TIMELIB_tovmstime will convert from the library's time format to VMS time format (64 bit unsigned count of ten nanosecond intervals since 17-NOV-1858). This function is optional. If not supported it should be specified as NULL in the library's function dispatch vector.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL TIMELIB_tovmstime (void *time, void *vmstime)
```

Arguments:

time	Pointer to time buffer in library's time format
vmstime	Pointer to buffer to receive VMS time format

Return values:

PFS_SUCCESS	Converted
PFS_FAILURE	Invalid time

11.7 TIMELIB_totexttime

Description:

TIMELIB_totexttime will convert from the library's time format to ASCII time format (dd-mmm-yyyy hh:mm:ss.t). This function is optional. If not supported it should be specified as NULL in the library's function dispatch vector.

Synopsis:

```
#include <pfs.h>

PFS_RETVAL TIMELIB_totexttime (void *time, void *texttime)
```

Arguments:

time	Pointer to time buffer in library's time format
texttime	Pointer to buffer to receive ASCII time format

Return values:

PFS_SUCCESS	Converted
PFS_FAILURE	Invalid time

12 STANDARD LIBRARIES

PFS provides two standard file system libraries for VMS, ODS2 DOS library and ODS2 MAC library. These two libraries are very tightly coupled. The partion is provided for functional separation only. The underlying file storage is mapped on the ODS2 file system for both libraries.

12.1 ODS2 DOS library

The ODS2 DOS library is responsible for all DOS related file access in the ODS2 file system. The library provides name translation, attribute storage, data storage and Lan Manager security data storage.

12.1.1 Namespace

The ODS2 DOS library uses the following algorithm for mapping DOS filenames to VMS filenames:

```
IF not case sensitive THEN convert lowercase to uppercase
ELSE treat lowercase as VMS illegal

IF first character is hyphen (-) treat as VMS illegal

IF character is underscore (_) AND next 3 characters are underscore,hex,hex
THEN treat first underscore as VMS illegal

FOR each VMS illeagal character DO
    Insert two underscores (__)
    Convert character to hex ASCII code

IF extention EQL "DIR" insert two underscores (__) before "DIR"

For example, NAME@.DIR would be converted to NAME__40.__DIR
```

The ODS2 DOS library uses the following algorithm to map VMS filenames to DOS filenames:

```
FOR each double underscore, hex, hex sequence DO
    Remove underscore
    Convert pair of hex ASCII codes to character

IF extention EQL "__DIR" remove double underscore

For example, NAME__40.__DIR would be converted to NAME@.DIR
```

NOTE

The above algorithm has the undesireable side effect of converting filenames with double underscores if they are entered by a host user or found on distribution media. There are plans to alter the mapping algorithm or condition the translation based on media type.

12.1.2 Attributes

The ODS2 DOS library stores DOS file attributes in a VMS applicaton ACE. The format of this ACE is shown below.

Figure 12-1: Format of the PATHWORKS DOS ACE

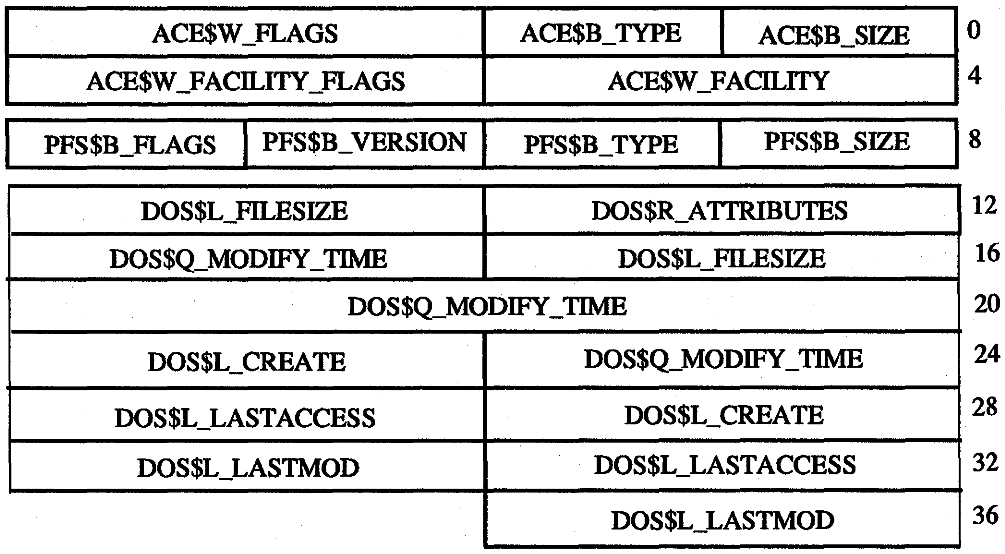


Table 12-1: Contents of the PATHWORKS DOS ACE

≈ Field Name	Description
ACE$B_SIZE	The total size of the VMS ACE, including the 8 byte ACE header plus the sum of all PATHWORKS sub ACEs.
ACE$B_TYPE	VMS ACE type. The PATHWORKS ACE is identified by ACE type 128 (PWRK$C_PATHWORKS_ACE).
ACE$W_FLAGS	VMS ACE flags. The PATHWORKS ACE specifies ACE$M_HIDDEN and ACE$M_NOPROPAGATE.
ACE$W_FACILITY	The VMS facility which owns the ACE. This field is specified as 1680 (690 hex) (PWRK$C_FACILITY_CODE).
ACE$W_FACILITY_FLAGS	VMS facility specific flags. This field is not used by the PATHWORKS ACE.

Table 12-1 (cont): Contents of the PATHWORKS DOS ACE

Field Name	Description
PFS$B_SIZE	Sub ACE length. The sub ACE follows the PFS$B_FLAGS field.This is the length of the sub ACE plus the longword sub ACE header.
PFS$B_TYPE	Sub ACE type. The PATHWORKS DOS ACE sub type is specified as 4 (PWRK$C_ACE_DOS).
PFS$B_VERSION	Sub ACE version. This field is not currently used and must be zero.
PFS$B_FLAGS	Sub ACE flags. This field is not currently used and must be zero.
DOS$R_ATTRIBUTES	DOS attributes word. The bits defined in this word are: DOSACE$M_READONLY DOSACE$M_HIDDEN DOSACE$M_SYSTEM DOSACE$M_VOLUME DOSACE$M_DIR DOSACE$M_ARCHIVE DOSACE$M_MULTI (OS/2) DOSACE$M_EXECONLY (OS/2)
DOS$L_FILESIZE	Total file data size for files not in stream or fixed RMS format or non sequential file orgranizations.
DOS$Q_MODIFY_TIME	Time at which the file size was calculated. This field will be zero if the file size field is not valid.
DOS$L_CREATE	DOS format create time.
DOS$L_LASTACCESS	DOS format last access time.
DOS$L_LASTMOD	DOS format lat modify time.

The ACE contains DOS file times in DOS format. The file size is calculated by reading the file and counting record lenghts (VAR file format). This count is marked with the file modification time such that it need not be recalculated unless the file has been modified.

The DOS$L_LASTACCESS field holds the time at which the file was last accessed, regardless of modification. This is an expensive field to maintain and may not be supported. This field would need to be set for read-only files (such as application images) each time the file was opened or closed.

12.1.3 Security

The DOS file system has no security data associated with it. However, DOS clients are supported by Lan Manager which defines its own security model. The ODS2 DOS library will support storage and retrieval of security information for Lan Manager.

NOTE

The file system library has no concept of the security model, association of security data nor security data hierarchy. This may force the server to querry all members of a file path in search of security data (Lan Manager security inheritance). This access may nullify the advantages of using path caches to optimize file access as the path may need to be processed member by member to obtain security data.

Alternately, the file system library may understand the security data hierarchy and obtain security data above the requested object. The path cache may perform better in this environment.

12.1.4 Datapaths

The ODS2 DOS library supports native DOS file formats (stream) as well as native VMS file formats (VAR, FIXED, INDEXED, etc). The library will use RMS for complex file organization (INDEXED). The library will use QIO for simple file organization (VAR, VFC, FIXED, STREAM XX).

The ODS2 DOS library will only create files in STREAM format. If a particular file format is desired on the host an external file conversion utility must be used.

12.1.5 FID cache

To facilitate ACE lookups and security data processing the ODS2 DOS library maintains recently accessed file headers in a cluster-wide distributed cache. This cache is used to obtain the DOS ACE on directory search functions as well as file access.

The FID cache is invalidated when a file is deleted or header data is modified. The local node cache invalidates the specific entry involved. Cluster-wide invalidation is limited to the hash chain which contains the entry in order to limit the amount of distributed locks.

12.1.6 Directory cache

The ODS2 DOS library maintains a cache of directory entries. This cache presents directories as fixed length structures to support the Search SMB. It is currently not clear whether this cache will be necessary given the Lan Manager directory structures.

12.1.7 Path cache

The ODS2 DOS library maintains a cache of recently translated paths. This cache is used to improve performance of file lookups. This cache contains path name to directory ID (DID) translations. Host security data for the directory is also stored here to imporve host security checking. It should be noted that VMS (RMS in particular) only stipulates security checking on the last member of a path. Was this not the case the path cache would not be useful for security data.

12.2 ODS2 MAC library

The ODS2 MAC library supports Macintosh clients. The library provides filename mapping, attribute storage, security data storage and Macintosh multifork file formats. The library maps all functions to the VMS ODS2 file system.

12.2.1 Namespace

The ODS2 MAC library stores Macintosh filenames in an application ACE associated with the file. This arrangement provides consistency between Macintosh filenames and Macintosh files. However, VMS provides very little to support filename lookups by anything other than VMS directories. It is necessary to establich external structures to provide this translation. The performance of the Macintosh file system is extremely dependent on the efficiency of these external structures.

NOTE

> The design of the ODS2 MAC library creates all external structures in memory, on demand. There are no external files to buffer the building of these in memory structures. While this design provides a high degree of consistency there are huge differences in perfomance for functions which hit the in memory structures and those for which the structures must be built. The overall performance will depend of the availability of memory to hold these structures and the frequency of invalidates.

In order to limit the length of directory searches for a Macintosh file there is a strict relationship between the Macintosh filename and the VMS filename (and hence the DOS filename). To allow an unrestricted filename relationship with no external structure file support would result in unacceptable performance for moderate to large directories. Preliminary performance measurements show that header lookups take between 5-15ms (VAX3100 M48). This would mean up to 30 seconds to locate a file in a directory of 2000 files (actual measurement).

File creates are done by converting the Macintosh name to a VMS name and creating the file. The file create will either a) fail due to existing file of the same name (and version) b) succeed with a higher version warning or c) succeed. Case a) and b) are failures. Macintosh filename creates are mapped to VMS names using the following algorithm:

```
Split filename and extension at first '.'
Remove all DOS illegal characters
Truncate to 8.3 format
UNTIL unique DO
    Convert DOS name to VMS name
    IF file exists replace last DOS character with digit 0-9
    IF replacement at '9' then filename conflict
END

For example, "Macintosh Filename" would be converted to MACINTOS.,
MACINTO1., MACINTO2., etc.
```

Macintosh filename lookups are performed by converting the Macintosh filename to a VMS wildcarded pattern and then searching for this filename. For each match the Macintosh ACE is examined for a matching filename. Macintosh filename lookups are converted to VMS names using the following algorithm:

```
Split filename and extension at first '.'
Remove all DOS illegal characters
```

```
Truncate to 8.3 format
Remove last DOS character
Convert DOS name to VMS name
Append VMS wilcard to filename and extension (*)
Search directory and match Macintosh filename against name stored in ACE

For example, "Macintosh Filename" would be converted to MACINTO*.*.
```

NOTE

It is possible that this algorithm may be modified for Macintosh-only installations. The conversion to DOS legal format could be replaced by a conversion to VMS legal format. This change may result in more meaningful filenames to Macintosh/host users.

12.2.2 Attributes

The ODS2 MAC library stores Macintosh attributes in an application ACE. This ACE shares the same physical VMS ACE as the DOS ACE. The header is shown here for completeness but is actually the same ACE header as for the DOS ACE. The PFS header is present on the Macintosh ACE, i.e. the data starting at byte 8.

Figure 12-2: Format of the PATHWORKS Macintosh ACE

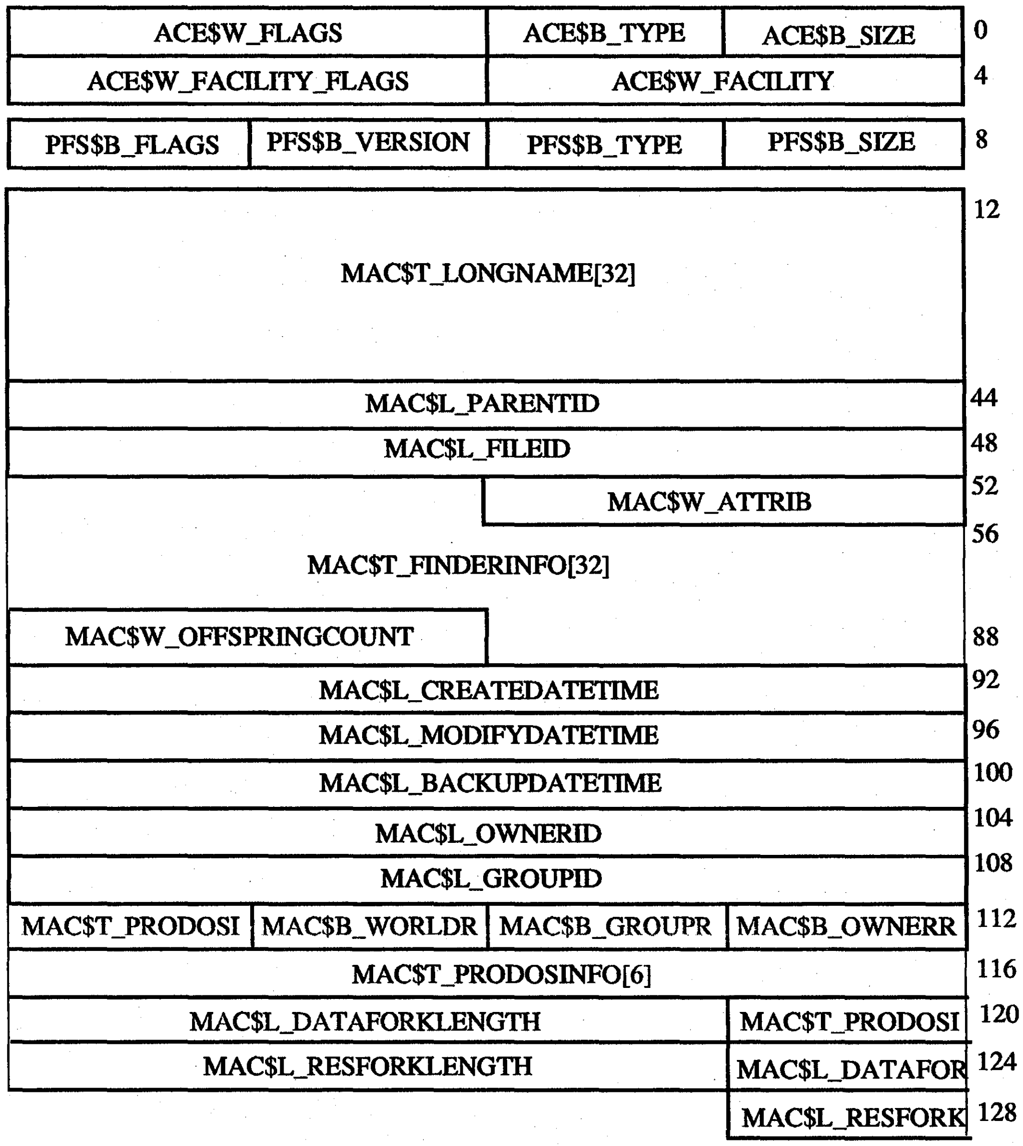


Table 12-2: Contents of the PATHWORKS Macintosh ACE

Field Name	Description
ACE$B_SIZE	The total size of the VMS ACE, including the 8 byte ACE header plus the sum of all PATHWORKS sub ACEs.
ACE$B_TYPE	VMS ACE type. The PATHWORKS ACE is identified by ACE type 128 (PWRK$C_PATHWORKS_ACE).

Table 12-2 (cont): Contents of the PATHWORKS Macintosh ACE

Field Name	Description
ACE$W_FLAGS	VMS ACE flags. The PATHWORKS ACE specifies ACE$M_HIDDEN and ACE$M_NOPROPAGATE.
ACE$W_FACILITY	The VMS facility which owns the ACE. This field is specified as 1680 (690 hex) (PWRK$C_FACILITY_CODE).
ACE$W_FACILITY_FLAGS	VMS facility specific flags. This field is not used by the PATHWORKS ACE.
PFS$B_SIZE	Sub ACE length. The sub ACE follows the PFS$B_FLAGS field.This is the length of the sub ACE plus the longword sub ACE header.
PFS$B_TYPE	Sub ACE type. The PATHWORKS DOS ACE sub type is specified as 4 (PWRK$C_ACE_DOS).
PFS$B_VERSION	Sub ACE version. This field is not currently used and must be zero.
PFS$B_FLAGS	Sub ACE flags. This field is not currently used and must be zero.
MAC$T_LONGNAME	Macintosh long filename.
MAC$L_PARENDID	32 bit Macintosh parent directory ID. This ID is used for access to the parent folder.
MAC$L_FILEID	32 bit Macintosh file ID. This ID may be used for direct access to the file.
MAC$W_ATTRIB	Macintosh file/directory attributes. The following attributes are defined: MAC$M_INVISIBLE MAC$M_SYSTEM MAC$M_BACKUPNEEDED MAC$M_RENAMEINHIBIT MAC$M_DELETEINHIBIT MAC$M_WRITEINHIBIT MAC$M_COPYPROTECT MAC$M_MULTIUSER
MAC$T_FINDERINFO	32 byte Finder Information.
MAC$W_OFFSPRINGCOUNT	Count of files contained in this directory
MAC$L_CREATEDATETIME	32 bit Macintosh format file creation time
MAC$L_MODIFYDATETIME	32 bit Macintosh format file modification time.
MAC$L_BACKUPDATETIME	32 bit Macintosh backup time.
MAC$L_OWNERID	32 bit Macintosh file owner ID
MAC$L_GROUPID	32 bit Macintosh owner group ID
MAC$B_OWNERRIGHTS	Access rights for file owner
MAC$B_GROUPRIGHTS	Access rights for file owner's group members.
MAC$B_WORLDRIGHTS	Access rights for others.

Table 12-2 (cont): Contents of the PATHWORKS Macintosh ACE

Field Name	Description
MAC$T_PRODOSINFO	6 byte Pro DOS Information
MAC$L_DATAFORKLENGTH	Length of the data fork, in bytes.
MAC$L_RESFORKLENGTH	Length of the resource fork, in bytes.

The times stored in the ACE are in Macintosh format. The fileID and parentID fields are modified VMS FID format. The sequence field and relative volume number fields are shortened to map to 32 bits. This requires a direct index file lookup to translate the file number back to the VMS FID. Again, this design choice has been made to eliminate the need for external files describing the Macintosh environment.

The library does not maintain the file creation times, modification times or backup times in the Macintosh ACE. This is the responsibility of the server.

12.2.3 Security

The ODS2 MAC library stores Macintosh security data in the appropriates fields of the Macintosh ACE (described above). The data is not interpretted.

Macintosh has a concept of "giving folders away". To Macinsosh, this is as simple as changing the owner of a directory. As file protection in Macintosh is inherited there is no further modification required. VMS has no such concept. It may be required for the server to modify each file in the directory to be "given away". This is likely a time consuming task. PFS supports this function by providing functions to change the host owner of a file. The server must use a combination of directory enumerates and change owner functions to complete the host mapping of security changes associated with the new owner.

12.2.4 Datapaths

The ODS2 MAC library supports the native VMS file formats are Macintosh data fork only files. The resource length for these files will always be returned as zero. The library supports a special file format to handle two forks per file. This file format is described in Appendix E.

The library will create files in STREAM format UNLESS a resource fork is created prior to the data fork. In this case the Macintosh file format is used on create. If a resource fork is added to a STREAM file it will be converted to a Macintosh format file (by remapping block 1 of the file). Non-stream files can not have a resource fork added to them with out conversion to stream format first. The library does not support this.

12.2.5 Name cache

The ODS2 MAC library maintains a cache of recently translated Macintosh filenames. This cache can only be used for file lookups as a miss in the cache is never sufficient to declare a file does not exist. (However, a hit would indicate the file already exists). The cache is tightly coupled to the ODS2 DOS FID cache and invalidates are done in the exact same manner.

Appendix A - VMS ODS level 2 file system

This appendix contains information about the VMS ODS level 2 file system. This information is presented to provide context for evaluating the mapping between NOS file systems and ODS2. The information herein is meant to be complete. Only the attributes and semantics relavent to NOS file systems are presented.

A.1 Directory structure

ODS2 uses hierarchial directory structure. Directory files appear as contiguous variable length files with variable record format. Records can not cross record boundaries.

Directory entries are packed within disk blocks. The records are arranged alphabetically. The records will be shuffled when a new entry is added to maintain alphabetic order.

Directory entries contain filenames, version numbers and file identificaton information. File identification information (FID) is associated with a specific version of each file. The individual version to FID mapping records are stored in order following the filename record.

Directory nesting depth is not limited by ODS2. However, RMS limits the depth of a directory specification to 8 levels. Unlimited depth may be processed by RMS with the use of concealed logical names. The names specify at least the part of the directory tree which would exceed 8 levels.

VMS BACKUP is limited to 8 levels in a directory tree. There is no warning that additional directory levels are being skipped.

A.2 File structure

ODS2 associates file attributes and generic file meta data with files in the file header. The file header is stored in the index file and is accessed by the file identification number (FID). The FID is a 48 bit structure which contains the relative volume number (volume number of bound volume set), sequence number (used to identify the instance of the file number) and file number. The file number is the index into the index file.

ODS2 provides direct file access by FID. The FID is sufficient to uniquely identify a file on a volume. No additional directory information is required.

The file header maps the virtual blocks in the file to logical blocks on the disk. Only one set of file retrieval pointers are maintained. This set coresponds to the data portion of the file.

The file header contains ACE information. This information specifies aditional security information, RMS attributes, or application specific information. PFS makes extensive use of the application ACE capabilities of ODS2 to associate NOS data with a file.

A.2.1 Access Control Lists (ACL)

ODS2 provides storage of information in the file header. Multiple file headers will be used if this information will not fit in the primary header. Additional fil headers are allocated from the index file and chained to the primary header. (This reduces the number of file which can be stored on the volume).

Access control lists are lists of Access Control Elements (ACE). While the term implies the information associated with the list controls access to the file, generic information may be stored in ACEs.

VMS XQP (extended QIO processor) provides access to information strored in the file header. ACEs may be added, deleted or modified. The XQP accepts multiple ACE manipulation functions per invocation. However, not all combination of functions will result in predictable results. The XQP maintains context information which is used to address a specific ACE. There is no direct address capability, however, a specific ACE may be located and the current pointer set to it. Once an ACE is located it may be modified or deleted. It is possible to locate multiple ACEs and modify them in a single invocation but FIND functions must be interspersed within the function list to maintain correct ACE positioning. Multiple new ACEs may be added without too much trouble.

A.3 File attributes

ODS2 maintains a set of file attributes. These attributes specify the file organization, record format, access times, etc. While this information may be common with some of the NOS file attributes, a complete mapping is not possible.

A.3.1 File creation time

The time at which a file is created is stored in the file header. This time is set when an XQP create function is executed.

A.3.2 File revision time

The file revision time is modified when a write function or modify function is executed. Initially the revision time is set to the creation time.

A.3.3 File backup time

The VMS BACKUP utility sets the time at which a file is backed up. This field may be used to determine if a file has been modified since the last backup.

A.3.4 File expiration time

ODS2 allows a specification of time at which file may not be accessed.

A.3.5 File organization

ODS2 itsefk does not provide any support for file organization. Files are simply collections of logical blocks. However, VMS RMS does provide various file organizations and in order to process a file the organization must be known and understood. RMS provides three file organizations:

SEQUENTIAL	Records are stored sequentially. Access is allowed either sequentially or by record address. Records may be variable length or fixed.

RELATIVE	Records are stored in fixed length blocks addressable via block number. The records within the blocks may be of any size. The record blocks may or may not be related to disk blocks.
INDEXED	Records are chained to an index key. Multiple indicies may be used. Records may be variable length.

A.3.6 Record structure

ODS2 itself does not provide any record structure. Files are accessible via 512 bytes blocks. However, VMS RMS does provide record format and in order to process a file this record format needs to be known and understood. Neyther ODS2 nor RMS provide any means for determining how much data is actually stored in a file. The only information available is where the current end of file mark is. RMS provides the following record formats:

VARIABLE	Records are prefixed by a count. The count is one word in length and counts the actual number of bytes in the record. All records are aligned on a word boundary (so there may be an extra byte in the actual record as stored in the file). Most VMS text files are stored in this format.
VFC	Variable with fixed control. The record contains a fixed number of bytes followed by a variable format record. File created with DCL OPEN, DCL WRITE and DCL CLOSE will be of this format.
FIXED	Fixed length records. The records may be of any size although 512 is most common. VMS images will be of this format.
STREAM	No record prefix. Records are terminated with <CR>, <LF> or <FF>, <VT> or <CR><LF>.
STREAM_CR	No record prefix. Records are terminated with <CR>.
STREAM_LF	No record prefix. Records are terminated with <LF>.
UNDEFINED	No record format.

A.3.7 Record attributes

ODS2 does not define any record attributes. As with record formats, the record attributes must be known and understood to process the file. VMS RMS defines the following record attributes:

BLK	Records may not cross block boundaries. Blank space may be found at the end of disk blocks.
CR	<CR><LF> to be prefixed to record when displayed on carraige control device. (Not applicable to file service).
FTN	Fortran carraige control. (Not applicable to file service).

PRN	Print carraige control. (Not applicable to file service).

A.4 File allocation

ODS2 allocates file in groups of disk blocks called clusters. The cluster size is determined when the disk is initialized.

Files may be allocated contiguous meaning all logical blocks of the file are contiguous.

A.4.1 File header

The file header contains all information stored about a file. The file attributes, ACEs, retrieval pointers and linkage to extension headers is stored in the file header.

File headers reside in the index file. Prior to processing a file, the index file must be read to obtain at least the primary header. This read is in addition to filename processing information located in the directory file.

A.4.2 Index file

ODS2 volumes contain an index file, INDEXF.SYS. This file is present on each volume, including each volume in a bound volume set. The index file is used to store file headers. There is a set of fixed length file headers which may be chained to store information about a file. The index file is addressed with the file identification number from the FID or DID.

A.4.3 Bitmap file

ODS2 contains a bitmap file which marks disk clusters either in use or free. The bitmap file is rebuilt if the volume is improperly dismounted. The bitmap is rebuilt by reading the index file and processing each file's retrieval pointers. In this manner, multiple linkages to disk blocks can be eliminated.

A.4.4 Quota file

ODS2 provides disk usage quotas for specific users. Any file allocations are subtracted from the user's quota. The user will be prevented from allocating more blocks than specified in the quota and overdraft limits provided by the quota file.

A.5 Security model

ODS2 security is provided in two levels, user identification (UIC) and ACLs. Four classes of users are defined:

OWNER	User whose UIC matches the file owner
GROUP	Users whose group portion of their UIC matches the group portion of the file owner UIC.
SYSTEM	Users in the system group [1,].
WORLD	Any user who does not fall in one of the above.

For each class there are four access modes:

READ	Users may read file or perform wildcard directory lookups.
WRITE	Users may write file or change its attributes.
EXECUTE	Users may execute file or perform specific directory lookups.
DELETE	USers may delete a file.

ACLs provide the same basic access with one additional access:

CONTROL	??

ACLs differ from UIC protection in that they are checked against a user's rights identifiers, not the user's UIC. In this manner groups of users may be granted or denied access independent of UIC group.

ACLs are applied after the UIC check is made. Therefore a user may be given access based on UIC even if the user is denied access based on the ACL.

Appendix B - MSDOS FAT file system

This appendix provides information about the MSDOS FAT file system. This file system is used in MSDOS clients. While many functions the server needs to provide are outside the scope of the FAT file system, many are directly related to the structure. This appendix is provided to present the issues which relate to the FAT file system.

B.1 Directory structure

MSDOS FAT provides variable length directories consisting of fixed records. Each record corresponds to a file. All file information is stored in the directory entry with the exception of file allocation table entries (FAT) which are pointed to by the directory record.

The filename is limited to 8.3 format, described in section 7.3.

The directory is not arranged in any partcular order. The directory expands as files are added and does not shrink once files are deleted. A given file's directory entry will occupy exactly the same position in the directory as long as the file exists. Once a file is deleted, its slot in the directory is free for reuse.

NOTE

The Search SMB is very much dependent on this directory structure. The success of a given server implementation is largely determined by the degree of consistency between the server's virtual directory stucture and that of MSDOS FAT. This structure can be seen in LanManager's implementation of the Search SMB.

B.2 File structure

MSDOS FAT files contain one data stream only. There are no extended attributes associated with the file. The file has no record structure.

B.3 File attributes

MSDOS FAT provides a set of five file attributes, described in section 7.3. There is only one file modification time stored with the file. This time is initially set to the file creation time.

B.3.1 Modification time

The MSDOS FAT file system saves the time at which a file is created or modified. Once a file is modified, the original file creation time is lost.

B.4 File Allocation

The MSDOS FAT file system allocates file blocks in groups called clusters. The size of a cluster is set at volume initialization time. For each cluster there is a 12 or 16 bit field in the File Allocation Table (FAT). 12 bit FATs are used for small volumes (less than 20740 blocks). 16 bit FATs are used for large volumes. The largest volume supported by FAT is approximately 10M bytes.

B.5 Security model

MSDOS FAT file system provides no native security. The security associated with an MSDOS client will be that of the server. If the MSDOS client is served by LanManager the security requirements will be those of LanManager. If the MSDOS client is supported by AFP the security model will be that of AFP.

Appendix C - Macintosh HFS file system

This appendix provides information about the Macintosh Hierarchial File System (HFS). This information is provided as a reference to the requirements placed on the server and hence on the file system.

C.1 Directory structure

Macintosh maintains a hierarchial directory structure. The directory information is stored in the catalog tree on each volume.

Filenames are limited to 32 characters and are described in section 7.3.

Each directory is assigned a unique 32 bit value which may be used to directly reference the directory. This information may be held by Macintosh applications including the Macintosh Finder.

A server file system must be capable of associating a 32 bit ID with each directory and provide direct access to the directory by this ID.

C.2 File structure

Macintosh maintains various file attributes associated with the file. The information is stored in the directory entry for the file. Macintosh assigns a unique 32 bit ID to each file. This ID may be stored in "alias" entries in V7 Macintosh file systems. Starting with V7, files must be accessible via this 32 bit ID. V7 clients can specify that a file ID is o be "swapped" between two files.

A server must be capable of assigning a unique 32 bit ID to each file and directly accessing the file by its ID. The server file system must either swap the file IDs on request or swap the data associated with each file ID.

Macintosh also supports two data streams per file. There are two sets of mapping pointers for each file.

A server file system must be capable of associating two data streams with each file.

C.2.1 Data fork

Macintosh files have a data stream associated with them. This data stream contains nromal file data and is accessible to all clients supported by a server.

C.2.2 Resource fork

Macintosh also associates a resource stream with the file. This stream is Macintosh specific and is assumed to have a specific format. The information stored in this stream is of little or no use to other client types. This stream may not be addressible to non Macintosh clients.

C.3 File attributes

Macintosh maintains a set file file attributes stored in the directory entry for the file. These attributes describe access to the file and file visibility. The Macintosh file attributes are described in section 7.3.

C.3.1 File creation time

Macintosh stores the time at which a file is created. This time will not be modified. All Macintosh times are signed 32 bit quantities designating the time before or after 00:00:00 January 1, 2000.

C.3.2 File modification time

Macintosh stores the time at which a file is modified. This time is initially set to the creation time.

C.3.3 File backup time

Macintosh also stores a file's backup time. This time may be set and used by external backup utilities.

C.4 File allocation

Macintosh allocates groups of disk blocks into allocation blocks. The size of the allocation block is set at volume intializatino time. Groups of allocation blocks are stored in records called extents. Each extent is an allocation block number followed by the count of blocks in the extent. The first set of extents (3 records) is stored in the directory entry for the file. If a file requires additional extents they are stored in the extents tree. The extents tree is arranged as a set of index nodes containing three extent descriptors. The index nodes are kept sorted by file ID and file allocation block number.

This arrangement is conceptually similar to ODS2s retrieval pointers.

C.5 Security model

The Macintosh file system provides no native security. The security associated with a Macintosh client will be that of the server. Currently Macintosh clients are only served by AFP.

Appendix D - FSI interface

This appendix was written from notes taken during the initial review of the LMU FSI implementation. The structure and function of the FSI is described. Various notes about the application of the design to the VMS file system are included.

D.1 General Architecture

The LMU File System Interface (FSI) is designed to be used with multiple back end file systems. The file system selection is based on the concept of "path" ownership. This design will allow multiple file systems to be used in a server environment. The basic assumption is that various file systems can be used anywhere in the UNIX file system space. The path is the client file name translated into the server file system's semantics.

The FSI routines use a function dispatch table to execute file system specific tasks associated with the path's file system. Most of these routines are mapped one-to-one with the FSI routines. This scheme partitions the file system into two levels, general file access (performed at the FSI layer) and file system specific access (performed thru dispatch table). Functions common to all file systems are performed at the FSI layer. Functions to perform file system specific tasks are collectively known as "libraries".

NOTE

The FSI functions use UNIX features and assume that UNIX is under the file system (errno and UNIX error numbers). This assumption greatly reduces the overall effect of the library partition.

The concept of file system libraries is further reduced by the use of "special libraries" which map FSLIB functions to special FSI functions, most notably the FSI_setvmtime(), FSI_update_dt() and FSI_checkvolume() which map to MACUTILS library FSLIB functions FSLIB_chdir(), FSLIB_fchdir() and FSLIB_access(), respectively. While this provides dynamic loadable support for MAC style access, it is certainly to be viewed as somewhat less than clean. This library mapping is handled by a special check in the INIT_ENTRY loadable library support. The MAC library is not otherwise mapped. We do not have sources for this library extension.

It would probably be best if the FSI routines directly handled MAC extensions.

D.1.1 File Descriptor Multiplexing

The FSI implements "file descriptor multiplexing" to prevent client access failure due to server process file descriptor resource depletion.

The FSI makes calls available to perform multiplexing and to provide notification when automatic multiplexing is done.

NOTE

This mechanism seems to be UNIX specific and may not be required with SVR4. It would appear that this service really belongs in the file

> system library level, not the FSI. The FSI should be a platform independent interface and file multiplexing may be a phenomenon peculiar to UNIX.

Multiplexing will occur when an FSLIB_open call fails and returns the UNIX errno ENFILE (file table overflow) or EMFILE (too many open files). ENFILE will result in a call to FSI_needinodes which uses an internal count to determine how many files to close based on the number of times the function is called (the more times it is called the greater the number of files it will try to close at once). There is a limit of calling the function 4 times (magic number declared in multiple routines, forceopen, opencreate, FSI_needinodes). EMFILE will result in a call to a local routine (close_a_file) which will close FSI_closecount files. This variable is set by INI package calls and is fixed for each call. Both mechanisms result in a call to FSLIB_mpxclose to actually close open files.

D.1.2 Volume Services

The FSI does not provide volume level services. It must assume that the server layer has some knowledge of volumes and path names to volume directories. The server layer must also maintain information about volume status.

D.1.3 Directory IDs

The FSI has functions to support MAC style directory IDs. The interface is somewhat primitive and does not appear to be fully implemented. The current implementation returns a UNIX pathname of <root>/n for pathnames to MAC directories, where <root> is the UNIX pathname to the volume root and n is the directory ID number. This would likely force the listed "folder" names to be the same as their directory ID. While this may provide file storage it most likely would not be viewed as acceptable. The FSI also does not enforce this name convention of directories it creates. I would assume it would be left to the server to assign a directory ID to the FPCreateDir and pass this ID as the directory name to FSI_mkdir. The original folder name would either be stored by the server in its own database or lost. I would further assume that the server would have to convert the directory name to its ID for return to the client on FPOpenDir. If the server stored the actual name it would need to convert directory names on FPEnumerate.

NOTE

> Certainly this mechanism needs to be changed. In the VMS environment, the file ID provides a unique 24 bit number (32 with RVN) which could be used as the directory ID. It is not clear whether direct access via this FID is provided.
>
> A similar mechanism in the UNIX/OSF space needs to be investigated.

D.1.4 Namespace

The FSI has some knowledge of namespace, however, it is not implemented. The FSI could attempt to "claim" a path in the client namespace and convert the name to UNIX. The FSI could also return directory entries in the client namespace. The FSI passes all namespace issues to the underlying file system. This may result in many duplicated functions. While it may be less efficient a more general architecture would specify the native namespace as used by the FSI and require all FSLIB routines to operate in this namespace, converting names as required. The FSI would then convert names to the client namespace as required.

D.1.5 Streams

The FSI supports two streams per file, the primary stream (data stream) or Macintosh resource stream. The implementation of streams is left to the library. The FSI will specify the stream on file open calls. The basic assumption is only one stream may be accessed per open file and the stream must be specified at open time. This allows implementation of separate streams in separate files or both streams in one file. If a file is to have a resource stream it must also have a primary stream. The primary stream is always created when a file is created, regardless of the stream specified.

D.1.6 Extended Attributes

The FSI implements support of OS/2 extended attributes. This support is provided at the FSI level, not in the libraries. The library open function allows three streams, unlike the FSI open function. The FSI level uses library read and write functions to access the data in the extended attribute stream and interprets the data directly. The entire file containing the stream is locked for the duration of attribute access.

Extended attributes have an ASCII name and non specified data value associated with them. They are referenced by name and may be added, deleted or modified. Access to the attributes is provided thru two parallel structures, one specifying the name of the attribute to return and the other containing the return attribute (get functions) or attribute and value to add, modify or delete (set functions).

Attributes are stored in the stream as an array of attribute structures followed by the attribute name followed by the attribute value. The structure contains a field which indicates the total size of the structure plus name and value length. This size can be used to calculate the offset of the next attribute.
Deleted attributes are marked in the EA header and the space may be used to store a new attribute, if it fits. If no slots are found the stream will be extended to hold the new attributes. Attributes are not sorted. Deleted attributes are marked by a NULL name pointer. The header will hold 10 deleted attribute pointers. The rest must be found by searching the attribute list.

NOTE

The support of extended attributes is in rough shape. The attribute stream is read into a static buffer and specified attributes are copied to the return structure as needed. This design relies on non-preemtive scheduling and single process access. A lock would be required to synchronize extended attribute functions. There are file access calls which use separate static buffers (one for the EA header and one for the data). These file read functions can not cause a process switch. While the current LMU tasker may provide for this it is not clear this is desired in a general I/O environment. If the tasker is changed to allow process switch while read data is fetched from disk this code could break and allow a second process to overwrite the EA header or data buffers.

Certainly the support of extended attributes needs to be moved to file system libraries.

Extended attributes are stored in a file with the suffix ".r". It would appear this file can be opened directly, however, directory enumerates specifically suppress listing the files. It is not clear what would happen if a user created a file with the ".r" suffix. The UFS library open function checks for a ".r" suffix and if present opens the file as is. If it is not the filename is appended with ".r". This would result in "FILENAME.EXT.R". While UNIX may allow this filename, VMS would not. I would guess that if a user created a ".r" file, it would be suppressed on directory enumerates.

The code references the support of extended attributes as EAHACK. It is possible this support was added in a last minute fashion and will be reworked.

D.1.7 FSI Routine Classification

The FSI routines can be grouped into 5 major classes, directory access functions, file access functions, file attributes functions, path access functions and general support functions.

Directory access functions

FSI_chdir
FSI_diridfcn
FSI_diridini
FSI_getcwd
FSI_getdents
FSI_mkdir
FSI_rmdir

File access functions

FSI_access
FSI_close
FSI_copyfile
FSI_create
FSI_delete
FSI_fsync
FSI_lock
FSI_lseek
FSI_open
FSI_purge
FSI_read
FSI_rename
FSI_sync
FSI_truncate
FSI_unlock
FSI_utime
FSI_unmap
FSI_write

File attributes functions

FSI_chmod
FSI_chown
FSI_getattr
FSI_geteas
FSI_getcmnt
FSI_filesize
FSI_setattr
FSI_setcmnt
FSI_seteas

Path functions

FSI_getpathid
FSI_fullpath
FSI_shortpath
FSI_treetop

General support functions

FSI_init
FSI_mapname
FSI_mpxclose
FSI_needfds
FSI_needinodes
FSI_setlognores
FSI_setnotifympx
FSI_stat
FSI_statvfs

D.2 PATH ID (FSI_PATHID)

Path IDs are structures which describe the path to a file. The path has attributes associated with it which may be the parent directory attributes.

Many calls operate on a path ID which contains the following information:

Function pointers

This field contains a pointer to the function dispatch table for the file system which "owns" this path.

Full path name

This field contains a string of fixed length to hold the full file name in the syntax of the server file system.

Short path name

This field contains a pointer into the full path name buffer which points to the start of the path which needs to be resolved, i.e. the point past the current default directory.

End tree top

This field contains a pointer into the full path name buffer which points to the start of the path beyond the "tree top" (volume directory on the server file system). This field must be set by the server application.

FSI flags

This field points to the FSI flags of the file system which "owns" this path. The flags include the following information:

File system is real UNIX file system
Resource forks are supported
Extended attributes are supported
Case sensitive file names are supported
File system is mapped to another file system (alias)
Mask of FSI status elements supported
Mask of FSI attributes supported

Status

This field contains the FSI status structure. This structure contains the following information:

Mask of which elements are valid
UNIX stat() function structure
File generation number
Data stream identifier (resource, data, attributes)
Parent INODE structure (this must assume that UNIX file system is present)
Parent generation number
Count of entries in directory
Count of files in directory
Count of directories in entry
File attributes

Directory ID pointer

This field is a pointer to a cell which contains the current directory ID generation number to be used with MAC variable ID format AFP calls.

D.2.1 File ID (FSI_FID)

Many calls operate on a file ID, a structure which contains the following information:

Function pointers

This field contains a pointer to the function dispatch table for the file system which "owns" this path.

File status

This field contains the FSI status structure. This structure contains the following information:

Mask of which elements are valid
UNIX stat() function structure
File generation number
Data stream identifier (resource, data, attributes)
Parent INODE structure (this must assume that UNIX file
system is present)
Parent generation number
Count of entries in directory
Count of files in directory
Count of directories in entry
File attributes

File descriptor

This field contains the file system descriptor (UNIX). The descriptor may be marked as closed if multiplexing has occurred.

File descriptor information (low, high, closed)

This field indicates which type of file descriptor this file is associated with.

Data stream identifier

This field indicates which data stream is being accessed, primary stream (data stream), resources stream or attributes stream.

Current file offset

The current file offset is preserved in case the file is closed due to file descriptor multiplexing. The file will be reopened and positioned here when the file is next accessed.

Open file reference count

This field contains the count of file IDs which point to this file.

Multiplex control count

This field contains the count of how many times the file is currently ineligible for multiplexing. The file may be closed if the count is zero.

Open flags

The file open mode must be preserved in case the file descriptor is closed due to multiplexing. The file will be reopened using this mode when it is next referenced.

File flags

Locking flag and file written flag.

File mapping information

[Need to find out how this works.]

FSI flags

This field points to the FSI flags of the file system which "owns" this path. The flags include the following information:

File system is real UNIX file system
Resource forks are supported
Extended attributes are supported
Case sensitive file names are supported
File system is mapped to another file system (alias)
Mask of FSI status elements supported
Mask of FSI attributes supported

End tree top pointer

This field contains a pointer into the full path name buffer which points to the start of the path beyond the "tree top" (volume directory on the server file system). This field must be set by the server application.

Full path name

This field contains a string of fixed length to hold the full file name in the syntax of the server file system.

D.3 ROUTINE SUMMARY

D.3.1 FSI_access

Description:

This function will determine if a file may be accessed according to the mode specified.

Synopsis:

FSI_Access (FSI_PATHID *pathid, int perms)

Algorithm:

```
BEGIN
    Check perms argument for validity
    Dispatch FSLIB_ACCESS (pathid, perms)
END
```

D.3.2 FSI_chdir

Description:

This function will change the working directory. Modifies global variables FSI_curdir, FSI_curdirlen.

Synopsis:

FSI_chdir (FSI_PATHID *pathid)

Algorithm:

```
BEGIN
    IF Current directory <> pathid THEN BEGIN
            Dispatch FSLIB_chdir (pathid)
            Copy fullpath to FSI_curdir
    END
END
```

D.3.3 FSI_fchdir

Description:

This function will change the working directory. Modifies global variables FSI_curdir, FSI_curdirlen.

Synopsis:

FSI_fchdir (FSI_FID *fp)

Algorithm:

```
BEGIN
    IF Current directory <> fp THEN BEGIN
            IF fp multiplex closed THEN Dispatch FSLIB_mpxopen (fp)
            Dispatch FSLIB_fchdir (fp)
            Copy fullpath to FSI_curdir
    END
END
```

D.3.4 FSI_chmod

Description:

This routine will change the access permission to the specified file.

Synopsis:

FSI_chmod (FSI_PATHID *pathid, mode)

Algorithm:

```
BEGIN
```

```
    Dispatch FSLIB_chmod (pathid, mode)
END
```

D.3.5 FSI_fchmod

Description:

This routine will change the access permission to the specified file.

Synopsis:

FSI_fchmod (FSI_FID *fp, mode)

Algorithm:

```
BEGIN
    IF fp multiplex closed THEN Dispatch FSLIB_mpxopen (fp)
    Dispatch FSLIB_chmod (fp, mode)
END
```

D.3.6 FSI_chown

Description:

This routine will change the owner of the specified file

Synopsis:

FSI_chown (FSI_PATHID *pathid, user_id, group_id)

Algorithm:

```
BEGIN
    Dispatch FSLIB_chown (pathid, user_id, group_id)
END
```

D.3.7 FSI_fchown

Description:

This routine will change the owner of the specified file

Synopsis:

FSI_fchown (FSI_PATHID *pathid, user_id, group_id)

Algorithm:

```
BEGIN
```

```
    IF fp multiplex closed THEN Dispatch FSLIB_mpxopen (fp)
    Dispatch FSLIB_chown (pathid, user_id, group_id)
END
```

D.3.8 FSI_close

Description:

This function will close a file.

NOTE

> The data fork and extended attributes fork are currently implemented in separate files. These files will not have equivalent modification times and may therefore not be backed up as a pair.

Synopsis:

FSI_close (FSI_FID *fp)

Algorithm:

```
BEGIN
    IF written THEN Set volume modify time
    IF last reference THEN BEGIN
            DEQUEUE fp
            Dispatch FSLIB_close
    END
END
```

D.3.9 FSI_copyfile

Description:

This function will copy a file. The resource fork is discarded (truncated) if the destination file system does not support it. The extended attributes fork is also discarded if the destination file system does not support it.

Synopsis:

FSI_copyfile (FSI_PATHID *src, FSI_PATHID *dest, dostream, action)

Algorithm:

```
BEGIN
    IF src does not exist THEN error
    IF read only fs OR no copy THEN error
    IF dostream resource AND dest not supported THEN error
    IF dostream attributes AND dest not supported THEN error
    Open src primary stream
    IF dest does not exist THEN BEGIN
            Create dest primary stream
            Copy file attributes from src
    END
    ELSE Open dest primary stream
    FOR all streams DO BEGIN
            Dispatch FSI_lock (src)
            Dispatch FSI_lock (dest)
            Dispatch FSLIB_ffilesize (src)
            FOR all bytes DO BEGIN
                    Dispatch FSLIB_read (src)
                    Dispatch FSLIB_write (dest)
            END
            Dispatch FSI_unlock (src)
            Dispatch FSI_unlock (dest)
            Dispatch FSI_close (src)
            Dispatch FSI_close (dest)
            Open next src stream
            Open next dest stream
    END
    IF FSLIB_copyfile THEN Dispatch FSLIB_copyfile
    IF MAC application THEN update desktop
    Set volume modify time
END
```

D.3.10 FSI_create

Description:

Create a new file or truncate an existing file.

NOTE

There is an FSI_FID sharing mechanism which will return a pointer to a previously allocated FID if the file is already open. Note that FSI_create will truncate this file without explicit lock checking or synchronization with other readers and or writers. Mandatory locking appears to be defeated in this case.

FSLIB_open allocates the FSI_FID. It also initializes the following fields of the FSI_FID:

fullpath (copied from pathid)
fd (returned by UNIX)
fdinfo (fd low or high)
status (copied from passed statbufp)
flags (mandlock set from st_mode)
mapaddr (allocated)
maplen (st_size)

FSI_create initializes the following fields of the FSI_FID following a successful call to FSLIB_open (actually done in local routine opencreate):

refcnt (set to 1)
stream (FSI_PRIMARY)
oflag (O_RDWR)
funcptrs (copied from pathid)
fsflags (copied from pathid)
endtreetop (copied from pathid)
nompx (if file not regular or directory)

Synopsis:

FSI_create (FSI_PATHID *pathid, mode, uid, gid, FSI_CREATE_TYPE type, FSI_FID **fp)

Algorithm:

```
BEGIN
    IF type is FSI_MAKETMP THEN BEGIN
       [Need to supply description here]   END
    ELSE BEGIN
            IF path does not exist THEN get parent attributes
            ELSE get file attributes
            IF read only THEN error
            IF type is FSI_MAKENEW and file exists THEN error
            IF file already open THEN BEGIN
                    Dispatch FSLIB_truncate
                    Use existing FID
            END
            ELSE BEGIN
                    Dispatch FSLIB_open (pathid, &pathid->status, -
                            O_RDWR | O_CREAT | O_TRUNC, mode,
FSI_PRIMARY, -
                            FSI_NOMAP, fp)
                    IF no more file space THEN start multiplex close
                    IF too many open files THEN close any files
                    IF access denied OR image busy OR readonly fs -
                    OR no memory OR no space OR no more processes -
                    THEN error
                    Initialize the remainder of the FID
                    Add it to the FID list
                    IF file does not exist THEN BEGIN
                            IF FSI_PRIMARY stream THEN -
                            Dispatch FSLIB_fchown
                            Dispatch FSLIB_fstat
                            IF FSI_PRIMARY THEN pathid->status = fp->status;
                    END
            END
    END
END
```

D.3.11 FSI_delete

Description:

Delete a file.

Synopsis:

FSI_delete (FSI_PATHID *pathid)

Algorithm:

```
BEGIN
    IF file does not exist THEN error
    IF readonly OR no delete THEN error
    IF no_purge THEN error
    Dispatch FSLIB_purge (pathid)
    IF MAC application THEN update desktop
    Set volume modify time
END
```

D.3.12 FSI_diridinit

Description:

This routine will initialize the handling of directory IDs.

Synopsis:

FSI_diridinit (dodirids, diridptr)

Algorithm:

```
BEGIN
    FOR any non mapped file system DO
    Dispatch FSLIB_diridinit (dodirids, diridptr)
END
```

D.3.13 FSI_diridfunc

Description:

This routine handles directory ID functions, FSI_DIRID_GET, FSI_DIRID_OPEN, FSI_DIRID_CLOSE. The DIRID_OPEN call indicates a volume has been mounted and a new set of directory IDs are to be used. DIRID_GET will convert a directory ID and UNIX pathname (representing the volume root) to a full unix pathname to the directory. DIRID_CLOSE indicates the volume has been closed.

Synopsis:

FSI_diridfunc (cmd, startpath, dirid, ptr, pathbuf, buflen)

Algorithm:

```
BEGIN
    Verify startpath is a valid UNIX directory
    Dispatch FSLIB_diridfunc
END
```

D.3.14 FSI_ffilesize

Description:

This function will return the number of bytes stored in the file.

Synopsis:

FSI_ffilesize (FSI_FID *fp, size)

Algorithm:

```
BEGIN
    IF fp multiplex closed THEN Dispatch FSLIB_mpxopen (fp)
    Dispatch FSLIB_ffilesize (fp, size)
END
```

D.3.15 FSI_fsync

Description:

This routine will flush any written buffers associated with the file.

Synopsis:

FSI_fsync (FSI_FID *fp)

Algorithm:

```
BEGIN
    IF fp multiplex closed THEN Dispatch FSLIB_mpxopen (fp)
    Dispatch FSLIB_fsync (fp, size)
END
```

D.3.16 FSI_fullpath

Description:

This function will return the full UNIX pathname of the file

Synopsis:

FSI_fullpath (FSI_FID *fp, pathbuf, pathlen)

Algorithm:

```
BEGIN
    Copy fullpath from fp to pathbuf
END
```

D.3.17 FSI_getattr

Description:

This function will return the requested file attributes and update the FSI_PATHID structure. Attributes which may be requested are as follows:

FSI_AT_DIRID - Directory ID
FSI_AT_BTIME - Backup time
FSI_AT_CREATE - Creation time
FSI_AT_F_INFO - Finder info
FSI_AT_ARCHIVE - File is archived
FSI_AT_HIDDEN - File is archived
FSI_AT_SYSTEM - File is a system file
FSI_AT_NOREN - File can not be renamed (can be copied)
FSI_AT_NODEL - File can not be deleted
FSI_AT_NOCOPY - File can not be copied (can be renamed)
FSI_AT_READONLY - File is read only
FSI_AT_NOPURGE - File is deleted on delete
FSI_AT_MACAPPL - File is Macintosh application
FSI_AT_MULTIUSER - File can be opened simultaneously
FSI_AT_EXECONLY - File is execute only
FSI_AT_INDEXED - Netware index file
FSI_AT_TRANS - Netware transation tracking
FSI_AT_RDAUDIT - Netware transaction tracking
FSI_AT_WRAUDIT - Netware transaction tracking

Synopsis:

FSI_getattr (FSI_PATHID *pathid, mask, FSI_ATTR *attrp)

Algorithm:

```
BEGIN
    Dispatch FSLIB_getattr (pathid, mask, attrp)
    Copy attrp to pathid
END
```

D.3.18 FSI_fgetattr

Description:

This routine will return the requested attributes and update the FSI_FID structure. Attributes and masks are the same as for FSI_getattr.

Synopsis:

FSI_fgetattr (FSI_FID *fp, mask, FSI_ATTR *attrp)

Algorithm:

```
BEGIN
    IF fp multiplex closed THEN Dispatch FSLIB_mpxopen (fp)
    Dispatch FSLIB_fgetattr (fp, mask, attrp)
    Copy attrp to fp
END
```

D.3.19 FSI_getcomment

Description:

This function will return a comment associated with a file. This is presumably present to support the MAC desktop database.

Synopsis:

FSI_getcomment (FSI_PATHID *pathid, commentbuf, commentlen)

Algorithm:

```
BEGIN
    Dispatch FSLIB_getcomment (pathid, commentbuf, commentlen)
END
```

D.3.20 FSI_getcmd

Description:

This function will return the current working directory.

Synopsis:

FSI_getcwd (cwdptr)

Algorithm:

```
BEGIN
    Set cwdptr to FSI_curdir
END
```

D.3.21 FSI_getdents

Description:

This function will return directory entry names in a specified format. The directory structure contains a longword ID, length word and text buffer. The name is returned in the namespace as specified below.

FSI_UNIXNAME - Use UNIX format
FSI_DOSNAME - Use DOS format
FSI_OS2NAME - Use OS/2 format
FSI_MACNAME - Use Macintosh format

The NBYTES parameter specifies how large the direntp buffer is and BYTESREAD specifies how much data was actually written to the buffer. OFFSET specifies where to start the read.

The dirent structures is defined as follows:

```
unsigned long d_ino; /* Unique identifier for file */
unsigned short d_reclen; /* Size of this record */
unsigned short d_namlen; /* Length of filename */
char d_name[MAXNAMLEN+1]; /* Buffer for filename */
```

Multiple entries may be packed in the buffer and may be found by using the buffer offset plus the d_reclen parameter.

Synopsis:

FSI_getdents (FSI_FID *fp, struct dirent *direntp, nbytes, offset, namespace, bytesread)

Algorithm:

```
BEGIN
    IF fp multiplex closed THEN Dispatch FSLIB_mpxopen (fp)
    Dispatch FSLIB_getdents (fp, direntp, nbytes, offset, namespace, bytesread)
END
```

D.3.22 FSI_getextattr

Description:

This function will return the extended attributes specified in the return buffer provided. The function will return the size of the return attributes in case the buffer is not large enough. It is the caller's responsibility to allocate a buffer large enough and call the function again. The function will fail if the buffer is not large enough.

Synopsis:

FSI_getextattr (FSI_PATHID *pathid, FSI_EAOPS *eaopsp)

Algorithm:

```
BEGIN
    IF file does not exist THEN error
    IF extended attributes not supported by fs THEN error
    Dispatch FSLIB_stat for FSI_EXTATTRS stream
    Open or create the stream
    Dispatch FSI_lock for whole file containing stream
    Dispatch FSLIB_ffilesize
    IF no stream THEN BEGIN
            IF return buffer large enough THEN-
            set return buffer to indicate no attributes
            Set size of return buffer
    END
    ELSE BEGIN
            Dispatch FSI_read for EA header
            Dispatch FSI_read for EA data
            Scan all attributes and calculate stream size
            Store stream size in return buffer
            IF no attributes requested THEN done
            FOR all requested attributes DO BEGIN
                    If requested attribute in list THEN -
                    append attribute and value to return buffer
                    ELSE append NULL attribute value to return buffer
                    Set size of return buffer
            END
    END
    Dispatch FSI_unlock
    Dispatch FSI_close
END
```

D.3.23 FSI_getpathid

Description:

This function will initialize an FSI_PATHID structure used for subsequent access to the path. The function will determine if the path exists and which file system it belongs to. The function uses a combination of UNIX stat() calls and FSLIB_claim calls to resolve the path. There is a provision for handling path translation from the client namespace but it is not yet implemented.

The function may return one of three return codes, FSI_EXISTS (path exists and pathid contains information about the path), FSI_NOEXIST (path does not exist but parent does and pathid contains information about the parent) or FSI_FAILURE (neither path nor parent exists and pathid does not contain any information).

The UNIX stat() function will succeed if the path exists in one of the UNIX file systems. If the path represents a "pseudo" file system, (i.e. a file system not mounted) then stat() may fail even though the FSI can access the path. In this case, FSLIB_claim would be responsible for identifying the path.

NOTE

The FSI implementation is not complete within the LMU server. There are server functions which directly call UNIX I/O functions on resolved path names (chksvr4() called by chkuxpath() called by smbcreate() uses open() to check write access to a directory). This would seem to preclude support of "pseudo" file systems as generic entities. Pseudo file systems may find application in specific sections of the LMU server, for example, the implementation of the desktop database may use a pseudo file system.

The FSLIB_claim function may return one of 4 return codes, FSI_EXISTS (path exists and is in the file system supported by this library), FSI_NOEXIST (path does not exist but the parent does and is in the file system supported by this library), FSI_UNCLAIMED_EXISTS (path exists in UNIX file system but is not supported by this library) or FSI_UNCLAIMED_NOEXIST (path does not exist but parent exists in the UNIX file system but is not supported by this library.

NOTE

> The algorithm used by FSI_getpathid seems to resort to "forced claims" as the algorithm progresses. If a library returns an UNCLAIMED status it is "forced" to accept the path if no one else did. It is not clear what the benefit of this "last chance" mechanism could be. Either the path is supported or it is not.

Synopsis:

FSI_getpathid (path, startcase, FSI_PATHID *pathid)

Algorithm:

```
BEGIN
    Clear pathid structure
    IF relative path THEN append to working directory
    Copy resolved path to fullpath
    Setup shortpath
    FOR FSI_PSEUDO_FS file systems DO BEGIN
            Dispatch FSLIB_claim
            IF claimed THEN done FSI_EXISTS or FSI_NOEXIST
    END
    UNIX stat() the path
    IF path exists THEN BEGIN
            IF NOT FILLPATH(path pathid) THEN error
            IF UNIX namespace THEN done FSI_EXISTS
            IF NOT case sensitive creates supported THEN BEGIN
                    Dispatch FSLIB_claim
                    IF claimed AND file exists THEN done FSI_EXISTS
                    ELSE error
            END
            ELSE done FSI_EXISTS
    END
    Get parent path
    UNIX stat() the path
    IF path exists THEN BEGIN
            IF path is not a directory THEN error
            IF NOT FILLPATH(parent pathid) THEN error
            IF UNIX namespace THEN done
            Dispatch FSLIB_claim
            IF exists THEN BEGIN
                    IF NOT FILLPATH(path pathid) THEN error
                    done FSI_EXISTS
            END
            ELSE done FSI_NOEXIST
    END
    IF UNIX namespace THEN error
    FOR ALL file systems DO BEGIN
            Dispatch FSLIB_claim
            IF file exists AND unclaimed THEN BEGIN
                    IF NOT FILLPATH(path pathid) THEN error
                    done FSI_EXISTS
            END
            IF file does not exist AND unclaimed THEN BEGIN
                    IF NOT FILLPATH(parent pathid) THEN error
                    done FSI_NOEXIST
            END
    END
    IF not claimed THEN error
END
```

D.3.24 FSI_lock

Description:

This function sets a byte range lock on a file. The file may be locked from the start of the file or the end of the file. The offset is the distance from the set point. The length argument specifies how many bytes to lock (NULL implies the remainder of the file). The routine will either fail if the lock is set or it will block until the lock is released (the block is the responsibility of the FSLIB). The offset from the start of the file to the lock point is returned, if requested.

NOTE

There appears to be a bug in this routine in that the start argument is not updated unless the file is actually locked, i.e. if the file is mapped the start argument is not guaranteed to be correct.

Synopsis:

FSI_lock (FSI_FID *fp, type, offset, whence, length, dowait, start)

Algorithm:

```
BEGIN
    Check whence argument (SEEK_SET or SEEK_END)
    Check lock type (F_RDLCK or F_WRLCK)
    IF FSI_locksmatter AND file not memory mapped THEN BEGIN
            IF fp multiplex closed THEN Dispatch FSLIB_mpxopen (fp)
            IF offset is over UNIX limit THEN done (YIKES!!!)
            IF end of lock is over UNIX limit THEN -
            set end of lock to UNIX limit
            Dispatch FSLIB_lock (fp, type, offset, whence, length, dowait, start)
            IF NFS not running THEN ignore NFS errors
            ELSE IF error THEN error
            Disallow multiplex closing this file (increment reason)
    END
    ELSE set start argument to start offset of lock
```

```
END
```

D.3.25 FSI_lseek

Description:

This function will set the current file position to that specified.

NOTE

This routine must be present for compatibility only as file position is not guaranteed across any FSI calls.

Synopsis:

FSI_lseek (FSI_FID *fp, offset, whence)

Algorithm:

```
BEGIN
    Check whence argument (SEEK_SET or SEEK_END)
    Check offset argument
    Dispatch FSLIB_lseek (fp, offset, whence)
END
```

D.3.26 FSI_mapname

Description:

This function will convert the last component of the path to the namespace requested.

Synopsis:

FSI_mapname (FSI_PATHID *pathid, namespace, namebuf, buflen)

Algorithm:

```
BEGIN
    Dispatch FSLIB_mapname (pathid, namespace, namebuf, buflen)
END
```

D.3.27 FSI_fmapname

Description:

This function will convert the last component of the path to the namespace requested.

NOTE

This function DOES NOT reopen a multiplex closed file. This may be an oversight, especially if the file system library expects to store converted names in the file itself.

Synopsis:

FSI_fmapname (FSI_FID *fp, namespace, namebuf, buflen)

Algorithm:

```
BEGIN
    Dispatch FSLIB_fmapname (fp, namespace, namebuf, buflen)
END
```

D.3.28 FSI_mkdir

Description:

This function will create a directory.

NOTE

> The directory ID parameter is not supported in UFS and will be forced to 0.

Synopsis:

FSI_mkdir (FSI_PATHID *pathid, mode, uid, gid, dirid)

Algorithm:

```
BEGIN
    IF directory exists THEN error
    IF readonly THEN error
    Dispatch FSLIB_mkdir(pathid, mode, dirid)
    Dispatch FSLIB_chown(pathid, uid, gid)
    Set volume modify time
END
```

D.3.29 FSI_mpxclose

Description:

This function will multiplex close the specified file. It is presumed to be present to allow servers to determine the best candidates for multiplex closing without resorting to FSI forced multiplexing.

Synopsis:

FSI_mpxclose (FSI_FID *fp)

Algorithm:

```
BEGIN
    IF NOT fp multiplex closed THEN Dispatch FSLIB_mpxclose (fp)
```

```
END
```

D.3.30 FSI_needfds

Description:

This function specifies a number of UNIX file descriptors which must be available. If this number of file descriptors is not available then the function will multiplex close files until it is.

Synopsis:

FSI_needfds (count)

Algorithm:

```
BEGIN
    IF dup() a file descriptor THEN BEGIN
            close() the new file descriptor
            fcntl(F_DUPFD) as many file descriptors as needed
            close() them all
            IF not enough THEN multiplex close the balance
    END
END
```

D.3.31 FSI_needinodes

Description:

This function will multiplex close a number of files.

NOTE

This routine is primarily for internal FSI use.

Synopsis:

FSI_needinodes(timescalled, FSLIB_ptrs)

Algorithm:

```
BEGIN
    Get the number of files to close based on timescalled
    FOR all open multiplexable fp DO BEGIN
            Dispatch FSLIB_mpxclose (fp)
            IF notify on mpxclose THEN Dispatch FSI_notifympx
    END
END
```

D.3.32 FSI_open

Description:

This function will open a data stream for read or write access.

Synopsis:

FSI_open (FSI_PATHID *pathid, statbufp, oflag, stream, domap, fp)

Algorithm:

```
BEGIN
    IF NOT primary stream OR resource stream THEN error
    IF resource stream AND resource not supported THEN error
    IF primary stream AND NOT open read/write OR readonly OR -
    writeonly THEN error
    IF file does not exist THEN error
    IF read only AND open for write THEN error
    IF NOT primary stream THEN BEGIN
            Dispatch FSLIB_stat
            Get UID, GID and protection mode
    END
    ELSE use file default UID, GID and protection mode
    IF directory THEN open for read only
    IF file already open THEN BEGIN
            Dispatch FSLIB_truncate
            Use existing FID
    END
    ELSE BEGIN
            Dispatch FSLIB_open
            IF no more file space THEN start multiplex close
            IF too many open files THEN close any files
            IF access denied OR image busy OR readonly file system -
            OR no memory OR no disk space OR no more processes -
            THEN error
            Initialize the remainder of the FID
            Add it to the FID list
            IF file does not exist THEN BEGIN
                    IF FSI_PRIMARY stream THEN -
                    Dispatch FSLIB_fchown (fp, uid, gid)
                    Dispatch FSLIB_fstat (fp, FSI_ST_USTAT, &fp->status)
                    IF FSI_PRIMARY THEN pathid->status = fp->status;
            END
    END
END
```

D.3.33 FSI_purge

Description:

This function will delete a file.

Synopsis:

FSI_purge (FSI_PATHID *pathid)

Algorithm:

```
BEGIN
    IF file does not exist THEN error
    IF read only fs OR no delete THEN error
    Dispatch FSLIB_purge
    IF MAC application THEN update desktop
    Set volume modify time
END
```

D.3.34 FSI_read

Description:

This function will read data from the file.

Synopsis:

FSI_read (FSI_FID *fp, buffer, nbytes, offset, bytesread)

Algorithm:

```
BEGIN
    IF fp multiplex closed THEN Dispatch FSLIB_mpxopen (fp)
    IF NOT mandlock AND NOT mapped THEN lock record
    Dispatch FSLIB_read
    IF record locked THEN unlock record
END
```

D.3.35 FSI_rename

Description:

This function will rename a file.

Synopsis:

FSI_rename (FSI_PATHID *old, FSI_PATHID *new)

Algorithm:

```
BEGIN
    IF both paths not in same fs THEN error
    IF old file does not exist THEN error
    IF read only fs OR no delete THEN error
    Dispatch FSLIB_rename
    IF MAC application THEN update desktop
    Set volume modify time
END
```

D.3.36 FSI_rmdir

Description:

This function will delete a directory.

NOTE

> This function makes a call to FSI_checkvolume to determine if the directory can be deleted on a MAC volume. There is no information on this function call.

Synopsis:

FSI_rmdir (FSI_PATHID *pathid)

Algorithm:

```
BEGIN
    IF read only fs OR no delete THEN error
    IF current directory THEN set current to root
    Dispatch FSLIB_rmdir
    Set volume modify time
END
```

D.3.37 FSI_setattr

Description:

This function will set the file's attributes. These attributes are those which the FSI operates on.

Synopsis:

FSI_setattr (FSI_PATHID *pathid, attrip)

Algorithm:

```
BEGIN
    IF attributes not supported by fs THEN error
    Dispatch FSLIB_setattr
    Set volume modify time
END
```

D.3.38 FSI_fsetattr

Description:

This function will set the file's attributes. These attributes are those which the FSI operates on.

Synopsis:

FSI_fsetattr (FSI_FID *fp, attrip)

Algorithm:

```
BEGIN
    IF attributes not supported by fs THEN error
    IF fp multiplex closed THEN Dispatch FSLIB_mpxopen (fp)
    Dispatch FSLIB_setattr
    Set volume modify time
END
```

D.3.39 FSI_setcomment

Description:

This function will associate a string of up to 199 characters with a file name.

Synopsis:

FSI_setcomment (FSI_PATHID *pathid, string)

Algorithm:

```
BEGIN
    IF comment too long THEN truncate to 199
    Dispatch FSLIB_setcomment
    Set volume modification time
END
```

D.3.40 FSI_setextattr

Description:

This function will add, delete or modify extended attributes associated with a file. The GEA list member of the EAOPS structure is ignored for this function. The FEA list contains a list of attributes and their values. If the attribute does not exist it will be added. If the attribute exists it will be modified unless the value pointer is NULL, in which case the attribute will be deleted. Attributes not specified in the FEA list will remain unchanged.

Synopsis:

FSI_setextattr (FSI_PATHID *pathid, FSI_EAOPS *eaopsp)

Algorithm:

```
BEGIN
    IF file does not exist THEN error
    IF extended attributes not supported by fs THEN error
    IF no FEA list THEN done
    Dispatch FSLIB_stat for FSI_EXTATTRS stream
    Open or create the stream
    Dispatch FSI_lock for whole file containing stream
    Dispatch FSLIB_ffilesize
    IF no stream THEN BEGIN
        Write out attributes in FEA list
        Done
    END
    ELSE BEGIN
        Dispatch FSI_read for EA header
        Dispatch FSI_read for EA data
        FOR all FEA in list DO BEGIN
            IF attribute found THEN BEGIN
                IF value fits THEN modify existing entry
                ELSE BEGIN
                    Delete attribute
                    IF empty space THEN add attribute
                    ELSE increase size of stream buffer
                END
            END
            ELSE BEGIN
                IF empty space THEN add attribute
                ELSE increase size of stream buffer
            END
        END
    END
    Dispatch FSI_write for EA data
    Get clean stream buffer for remaining FEA
    FOR all FEA which did not fit DO add attribute
    Dispatch FSI_write for EA data
    Dispatch FSI_write for EA header
    Dispatch FSI_unlock
    Dispatch FSI_close
END
```

D.3.41 FSI_setlognores

Description:

This function specifies a routine for the FSI to call when resources have been exhausted.

Synopsis:

FSI_setlognores (routine)

Algorithm:

```
BEGIN
    Set FSI_LogNoResource to routine
END
```

D.3.42 FSI_setnotifympx

Description:

This function specifies a routine for the FSI to call when multiplexing begins.

Synopsis:

FSI_setnotifympx (routine)

Algorithm:

```
BEGIN
    Set FSI_notifympx to routine
END
```

D.3.43 FSI_shortpath

Description:

This function will set the short path element of the FSI_PATID structure to the point past the current directory, if it is part of the full path. If not the short path is set to the full path.

Synopsis:

FSI_shortpath (FSI_PATHID *pathid)

Algorithm:

```
BEGIN
    IF current directory in fullpath THEN -
            set short path past current directory
    ELSE set short path to full path
END
```

D.3.44 FSI_stat

Description:

This function will return file statistics in the UNIX stat format.

Synopsis:

FSI_stat (FSI_PATHID *pathid, stream, mask, statbufp)

Algorithm:

```
BEGIN
    IF mask not supported by fs THEN error
    IF stream NOT (FSI_PRIMARY OR FSI_RESOURCE) THEN error
    IF stream is FSI_RESOURCE AND not supported by fs THEN error
    Dispatch FSLIB_stat
    IF stream is FSI_PRIMARY THEN copy statbufp to pathid status
END
```

D.3.45 FSI_fstat

Description:

This function will return file statistics in the UNIX stat format.

Synopsis:

FSI_fstat (FSI_FID *fp, stream, mask, statbufp)

Algorithm:

```
BEGIN
    IF mask not supported by fs THEN error
    IF stream NOT (FSI_PRIMARY OR FSI_RESOURCE) THEN error
    IF stream is FSI_RESOURCE AND not supported by fs THEN error
    IF fp multiplex closed THEN Dispatch FSLIB_mpxopen (fp)
    Dispatch FSLIB_stat
    IF stream is FSI_PRIMARY THEN copy statbufp to fp status
END
```

D.3.46 FSI_statvfs

Description:

This function will return file information in a UNIX statvfs structure.

Synopsis:

FSI_statvfs (FSI_PATHID *pathid, statvfsbufp)

Algorithm:

```
BEGIN
    Dispatch FSLIB_statvfs
END
```

D.3.47 FSI_fstatvfs

Description:

This function will return file information in a UNIX statvfs structure.

Synopsis:

FSI_fstatvfs (FSI_FID *fp, statvfsbufp)

Algorithm:

```
BEGIN
    IF fp multiplex closed THEN Dispatch FSLIB_mpxopen (fp)
    Dispatch FSLIB_fstatvfs
END
```

D.3.48 FSI_sync

Description:

This function will flush all file system information from memory to disk.

Synopsis:

FSI_sync ()

Algorithm:

```
BEGIN
    FOR all non mapped fs DO Dispatch FSLIB_sync
END
```

D.3.49 FSI_ftruncate

Description:

This function will truncate a file.

Synopsis:

FSI_ftruncate (FSI_FID *fp, offset)

Algorithm:

```
BEGIN
    IF fp multiplex closed THEN Dispatch FSLIB_mpxopen (fp)
    Dispatch FSLIB_ftruncate
END
```

D.3.50 FSI_tretop

Description:

This function sets the treetop pointer in the pathid structure to the point past the "root directory" for a share point or mounted volume.

Synopsis:

FSI_treetop (FSI_PATHID *pathid, treetop)

Algorithm:

```
BEGIN
    IF treetop in full path THEN set treetop
    ELSE error
END
```

D.3.51 FSI_unlock

Description:

This function will unlock a range of bytes in the file.

NOTE

> The function will multiplex open a file and then try to release a lock. This should be guaranteed to fail as UNIX releases locks when a file is closed. Perhaps it is best to either leave the file closed and return success (the lock was actually released) or reopen the file and return success without unlocking anything.

Synopsis:

FSI_unlock (FSI_FID *fp, offset, whence, length)

Algorithm:

```
BEGIN
    IF whence NOT (SEEK_SET OR SEEK_END) THEN error
    IF FSI_locksmatter AND file not memory mapped THEN BEGIN
    IF fp multiplex closed THEN Dispatch FSLIB_mpxopen (fp)
    IF offset is over UNIX limit THEN done (YIKES!!!)
    IF end of lock is over UNIX limit THEN -
    set end of lock to UNIX limit
    Dispatch FSLIB_unlock
    Allow multiplex closing this file (decrement reason)
    END
END
```

D.3.52 FSI_unmap

Description:

This function will clean up a memory mapped file.

Synopsis:

FSI_unmap (FSI_FID *fp)

Algorithm:

```
BEGIN
    Dispatch FSLIB_unmap
END
```

D.3.53 FSI_utime

Description:

This function will set the modification time of a file.

Synopsis:

FSI_utime (FSI_PATHID *pathid, timebufp)

Algorithm:

```
BEGIN
    Dispatch FSLIB_utime
END
```

D.3.54 FSI_futime

Description:

This function will set the modification time of a file.

Synopsis:

FSI_futime (FSI_FID *fp, timebufp)

Algorithm:

```
BEGIN
    Convert fp to pathid
    Dispatch FSLIB_utime
END
```

D.3.55 FSI_write

Description:

This function will write bytes to a file.

Synopsis:

FSI_write (FSI_FID *fp, buffer, nbytes, offset, byteswritten)

Algorithm:

```
BEGIN
    IF fp multiplex closed THEN Dispatch FSLIB_mpxopen (fp)
    IF NOT mandlock AND NOT mapped THEN lock record
    Dispatch FSLIB_write
    Set dirty flag
    IF record locked THEN unlock record
END
```

Appendix E - RMS Extent for Macintosh file format

The Macintosh file system provides two data contexts per file rather than the usual single context. This concept makes it difficult to represent a Macintosh file in a file system which supports only single contexts. VMS Files 11 is such a file system.

There appear to be two approaches to this problem. The first represents the Macintosh file as two separate files. It is the responsibility of the software which provides access to the Macintosh file to associate the two separate files. This approach has a number of advantages, most noteworthy is the ability of the native file system to access either of the Macintosh contexts directly. However, there is a serious disadvantage in that the two separate files may be modified, moved or deleted such that the association is no longer valid. The second approach represents both data contexts in the same file. This approach solves the asociation of data contexts, however, Files 11 can not access either data context directly. It is necessary to have a translator between the native file system and the user such that the appropriate data co□ntext may be accessed. RMS provides such a mechanism in what is called an RMS extent. The capabilities of the extent are somewhat limited but do provide the basics for the type of translation necessary to access each data context. The only caveat is that the user MUST use RMS to access the file. If not, the internal file format is visible.

This paper describes a trial development of an RMS extent which provides access to the Macintosh DATA fork (one of the data contexts in the Macintosh file).

E.1 File Format

The trial development file format borrows from the mapping concepts of FIles 11 in that there is a set of retrieval pointers which map the virtual blocks of each data context to virtual blocks within the file. This mapping is exactly analogous to the virtual block to logical block mapping provided by Files 11.

The file consists of a header followed by data blocks or mapping blocks. To limit the overhead the first set of mapping pointers is contained in the header. As a further simplification all data blocks are aligned on a block boundary which provides for a simple revectoring of virtual blocks within the data context (alias data stream) to the virtual blocks within the file.

Data blocks are allocated as needed and mapped to one of two streams, the DATA stream or the RESOURCE stream. Each stream has its own set of mapping pointers and the file is limited to two streams for the purpose of this trial development. The extensions to multiple streams are straightforward, however, the file format assumes a fixed number of streams.

Mapping blocks are allocated as the streams become fragmented and there is no longer sufficient space in the file header to map blocks. The format of the mapping blocks is identical to that of the mapping blocks in the header. This concept is not implemented in the trial development. The streams may not be arbitrarily fragmented. The implementation chooses 16 mapping pointers in the header block (completely arbitrary choice, although the upper limit would be about 60 per stream). This limits the fragmentation to 16 individual segments. The tests performed were on contiguous streams mapped by a single pointer.

E.1.1 File Semantics

RMS provides a *File Semantic* feature which identifies the internal structure of a file which requires an RMS extent for access. RMS scans a file semantic tag structure to locate the routines which will provide access to the file. This tag structure is loaded at system startup time by the initialization routines of the extent image.

The trial development uses the file sematic tag "MACFILE". This tag is represented as the ASCII translation of "MACFILE" in the RMS *stored semantics*. When RMS finds a file with this tag, it will dispatch the routines specified by the extent image.

RMS will bypass the routines if the user supplies an *access sematics* tag which matches the *stored semantics*. It is assumed that the caller want to directly access the internal file format in this case. This access mode is not currently used by would be useful to a utility which could modify the Macintosh file internals (for building such a file directly from the host system for example).

E.1.2 Header

The header consists of three sections; allocation, stream descriptors and mapping blocks. The allocation information is simply the next virtual block for allocation (although this information could be obtained from internal RMS structures). The stream descriptors consist of three longwords; the end of stream VBN, the end of stream byte within the VBN and the offset to the first set of mapping pointers. The mapping pointers are one logword each and consist of four types; NULL, MAP, FREE and OFFSET.

E.1.2.1 Allocation

The allocation section simply consists of the next virtual block to be allocated. This section must be expanded to include allocation data for the mapping blocks

E.1.2.2 Stream Descriptors

There are currently two stream descriptors; one for the DATA fork and one for the RESOURCE fork. Each descriptor consists of three longwords to contain the end of stream VBN, the end of stream byte and the offset to the mapping pointers. If the number of streams per file is to be increased new descriptors would need to be added.

E.1.2.3 Mapping Pointers

The mapping pointers consist of one longword each and map streams, free blocks or mapping blocks. The pointer format is variable based on a two bit field in the upper two bits of the longword. Currently VBNs are limited to 16 bits which sets the upper limit to 32MByte file which can be represented. This number can be changed to accomodate the largest file expected or extended to map to the full Files 11 limit.

E.1.3 Data Stream Format

Currently the data stream is represented as a STREAM CR format with the assumption that it contain text. Clearly this needs to be extended. It is not clear how the data fork should be interpretted, there is no indication, short of scanning for non-printable characters which could be used to determine the data format. RMS based applications assume the file format is stored in the file and can be used to determine how to process the file. For the purposes of this tial development, we have assumed that the data should be returned as RMS VAR format with CR attributes and is stored as a stream of records terminated by <CR> (sample Macintosh text file is stored this way).

E.1.4 Resource Stream Format

The resource stream is simply represented as a stream of bytes. The caller will have as many bytes returned as will fit in the buffer. The file is still reported as RMS VAR format with CR attributes as this information needs to be returned before the stream access is done (RMS $CONNECT). While the support to read the resource fork is implemented it can not be accessed by RMS in this trial development.

E.2 Extension Structure

The RMS extent is structured as an initialzation routine, series of callout routines and a set of support routines. The basic approach was to use RMS facilities to read and write a block of the file and perform the rest of the record access in support routines. RMS supplies two such routines; RMS$GET_BUFFER and RMS$RELEASE_BUFFER. The routines access the RMS data cache and will perform file reads (if requested) or file writes (if requested). For the purpose of this trial development only those routines necessary to access a sequential text file have been implemented. Both sequential and random access to these records is provided.

The callout routines completely replace the normal RMS routines. This means the routines must update user fields of the RMS structures (FAB/RAB/XAB) and also move data to and from the user buffers pointed to in these structures.

E.2.1 Initialization

The extent initialization consists of a call to add the semantic tag to the RMS table and provide a set of callout entry points. RMS will call the routines declared by a non zero entry in the appropriate slot in the dispatch table. If an entry is zero, RMS will handle the function internally using the normal RMS access. RMS provides a standard "not implemented" callback routine which should be used if an RMS function is to be denied. IF the normal RMS handling for a function is sufficient, a zero should be placed in the dispatch table slot.

This is the only execution time function of the extent. It simply sets up the table, calls RMS to identify the sematics and exits. The remainder of the extent remains mapped and will be called in the context of an *RMS thread.*

E.2.2 RMS support routines

RMS provides a series of routines to provide the extent with access to internal data structures and file data. These routines are only partially implemented. The history of the RMS extent development is such that only the first phase of development was completed. This development was done to support the CDA architecture. Unfortunately, this developement only required read access to files and as such, no simple mechanisms for file writes and file extend operations are provided. These functions must be implemented by using the low level RMS calls and direct QIO access to the file (for file extends).

The trial development uses a small set of routines primarily for block level read and write access to the Macintosh file.

E.2.3 Data Structures

The extent uses a simple context block to store information needed across calls to process the file. This information includes the stream mapping data and various data buffers.

The extent caches mapping data while accessing the file. this data will be written back to the file when the stream is disconnected (either thru an RMS $DISCONNECT or an RMS $CLOSE).

E.2.3.1 CXT - Context Block

The context block is used to store the extent internal state information across RMS access calls. The information stored maps access to the file, identifies the current position in the stream and also stores pointers to RMS internal structures.

CXT$L_STMEOS - End of stream VBN

The stream EOS position is the last virtual block of the stream. This pointer is obtained from the Macintosh file header block (VBN 1 in the Macintosh file). This pointer will be updated for writes beyond end of file (if they cross into a new VBN). The field will be written back to the Macintosh file header when the stream is disconnected.

CXT$L_STMFFB - First free byte

The stream first free byte is the first free byte in the last block of the stream. Together, the two fields define the end of the stream. This position will be updated for writes beyond the end of stream. This field will be written back to the Macintosh file header when the stream is disconnected.

CXT$L_WINDOW - Mapping window

The mapping window contains a set of stream mapping pointers. The window is "turned" as the stream is accessed, if necessary. While the concept of turning is defined, it is not implemented for this trial development. A number of issues have been identified which will necessarily require modifications to the data structures to handle window turns.

As defined currently, a backward turn requires the window be turned back to the start of the stream and then turned forward to the requested VBN. A linked list of window pointers could be maintained to reduce this operation but there is a limit as to how many pointers may be maintained. While this implementation would reduce the need for complete turns, it would not eliminate it.

This area needs to be explored for the final development.

CXT$L_WINBASE - Base stream VBN of window

This field defines the starting stream VBN of the current mapping window. This field is used while translating stream VBN to file VBN.

CXT$L_BUF - General buffer

A 512 byte general bufer is allocated. It is not currently used but is envisioned to be necessary to handle window turns.

CXT$L_BUFFER - Data buffer

The current RMS data buffer's data pointer is stored in the context block, as well as the RMS data buffer pointer itself. The data buffer's data pointer is used as the base address for stream reads and writes.

CXT$L_BUFPTR

The current buffer pointer is stored to support sequential record access and also for record de-blocking. As the extent routines completely replace RMS routines, this de-blocking must be performed by the extent.

E.2.4 Global Routines

The trial development supports access routines necessary to test host based applications which deal with text files. These routines are generally limited to $GET, $PUT and $FIND access. The extensions to include $READ and $WRITE are straightforward. $EXTEND functions will be difficult to implement as the routines to actually extend a file are not provided by RMS. $TRUNCATE would simply convert the mapping pointers in the Macintosh file header to FREE pointers.

E.2.4.1 EXT_CONNECT

RMS $CONNECT callout routine.

The $CONNECT callout allocates space for the context block and links it to the internal RMS IRAB structure. This internal structure pointer is passed on all access callouts.

This callout is only a supplement to the normal RMS $CONNECT handling.

E.2.4.2 EXT_GET

RMS $GET callout routine.

The $GET callout translates stream VBNs to file VBNs, reads file blocks and de-blocks file records. File access by RFA or sequential access are supported. Read ahead access is not supported and is ignored.

This routine completely replaces the normal RMS $GET function.

E.2.4.3 EXT_PUT

RMS $PUT callout routine.

The $PUT callout translates stream VBNs to file VBNs and merges records into the file block. File access by RFA or sequential access are supported. Write behind access is not supported and is ignored.

This routine completely replaces the normal RMS $PUT routine.

E.2.4.4 EXT_FIND

RMS $FIND callout routine.

The $FIND callout simply sets the next VBN and BUFPTR fields for subsequent access. The specified file block is read in if not already in the data buffer.

This routine completely replaces the normal RMS $FIND routine.

E.2.4.5 EXT_DISCONNECT

RMS $DISCONNECT callout routine.

The $DISCONNECT callout writes out the final data buffer (if present), updates the Macintosh file header and deallocates the context block and data buffers.

E.2.4.6 EXT_DISPLAY

RMS $DISPLAY callout routine.

The $DISPLAY callout simply sets the FAB record format and attributes field to indicate a VAR CR file format. The XAB chain is also scanned to modify any XABFHC blocks present.

The $DISPLAY callout supplements the $DISPLAY function and the $OPEN function.

E.2.4.7 EXT_MUCK_XABFHC

This routine is called if an XABFHC block is present in the XAB chained, linked to the FAB.

This routine is called as a callback for the RMS$SCAN_XAB_CHAIN routine.

E.3 Restrictions

There are a number of restrictions on the extent and on its use.

E.3.1 File writes

File writes are possible but a direct QIO call must be made to extend the file allocation. It is not clear what internal state must be modified after this is done. (It is assumed that IFB$L_HBK is sufficient).

E.3.2 Buffer usage

The buffer use must be completely understood. There are a number of issues around buffer use which are somewhat unclear. In particular, the IFB$L_AVALCL field, which indicates the number of buffers available, is not maintained by the buffer calls provided. The field is currently updated after calls to RMS$GET_BUFFER. Failure to do this will bugcheck RMS as no buffers are available.

E.3.3 File updates

Tests have been performed with EDT and EMACS to determine if the contents of the file may be modified an preserve the file structure. Unfortunately, both editors (and probably most others) create a new version of the file which does not propagate the file structure. The resource fork is lost. Note that this is precisely the same behaviour as would be seen if the file was edited from a DOS client.

It is clear that the PATHWORKS file system MUST support Macintosh files in both *native mode* file structure and *Macintosh format* file structure. (It is currently envisioned that Macintosh files would not be stored in the *Macintosh format* unless a resource fork was present. Note that converting a *native mode* file to a *Macintosh format* file involves simply moving the first block and adding the Macintosh file header with two mapping pointers. This would have to be done when a resource fork was added to a *native mode* file).

E.3.4 Printing Files

It has been rumoured that various print symbionts do not use RMS to access the records of a file. This needs to be looked into closely as this would mean *Macintosh format* file could not be printed without conversion. This may be an issue for the PATHWORKS Print Subsystem

E.4 Issues

The purpose of this trial development was to demonstrate the capabilities or the RMS extent as applied to Macintosh files, test simple host utilities and get some insight into the issues around the file format. These objectives have been accomplished. It now needs to be decided if we should continue with this two data context file concept or if we should address the problems of representing Macintosh files as two separate files.

Appendix F - File System Configuration Parameters

This appendix lists the parameters which control the file system. Many parameters are present for tuning and evaluation of various file system features. The system is configured to run with default settings and feedback provided by the Configuration Monitor may change these defaults. Care needs to be taken when modifying these parameters.

F.1 PFS File System

Name: [PFS] RW_USE_CACHE
Type: BOOLEAN
Scope: CLUSTER-WIDE
Default: 1
Description:

This parameter enables or disables use of the global data cache within PFS. The parameter should only be cleared for file system testing.

Name: [PFS] TRAP_ACCVIO
Type: BOOLEAN
Scope: CLUSTER-WIDE
Default: 0
Description:

This parameter enables or disables trapping exception generated by PFS or a file system library. When set, exceptions are converted to function failures. When clear, exceptions cause process termination.

Name: [PFS] FILE_SEARCH
Type: BOOLEAN
Scope: CLUSTER-WIDE
Default: 1
Description:

This parameter enables or disables searching for directories when a file specification is received from the client. If the parameter is set PFS will look for a directory of the name specified if a file of that name is not found. If the parameter is clear PFS will return PFS_NOEXIST if the file is not found.

There have been changes made to the server which may require this parameter to be set always.

Name: [PFS] STAT_COLLECT
Type: BOOLEAN
Scope: CLUSTER-WIDE
Default: 0
Description:

This parameter enables or disables collection of PFS run time statistics. These statistics count the number of functions issued and the amount of time taken by various functions. This collection is not free and degrades performance less than

5%. This parameter should only be enabled for performance tuning related workloads.

Name: [PFS] INIT_FATAL
Type: BOOLEAN
Scope: CLUSTER-WIDE
Default: 1
Description:

This parameter enables or disables process exit on initialization failures.

Name: [PFS] COPY_BUFSIZ
Type: INTEGER
Scope: CLUSTER-WIDE
Default: 8192
Minimum: 512
Maximum: 8192
Description:

This parameter controls the size of the buffer used by PFS_copyfile(). The buffer is allocated from process memory and released prior to function completion. The buffer controls the size of data reads during copy operations.

Name: [PFS] SECURITY_MODE
Type: INTEGER
Scope: CLUSTER-WIDE
Default: 1
Minimum: 1
Maximum: 3
Description:

This parameter controls the security mode in which PFS operates. Legal values are:

1 - NOS security

Never check host security.

2 - HOST security

Always check host security.

3 - CREATOR security

Check host security only if the file was not created by the server.

If an illegal value is specified the parameter is defaulted to NOS security.

F.2 ODS2 File System

Name: [ODS2] CHKPRO_ENABLE
Type: BOOLEAN
Scope: CLUSTER-WIDE

Default: 1
Description:

This parameter enables or disables CHKPRO access checking. CHKPRO is called when the server is running in HOST or CREATOR security mode. The check may be disabled entirely by setting this parameter to "0".

Name: [ODS2] PATH_CHKPRO_ENABLE
Type: BOOLEAN
Scope: CLUSTER-WIDE
Default: 0
Description:

This parameter enables or disables CHKPRO access checking on the path to a file. CHKPRO is called when the server is running in HOST or CREATOR security mode. The check may be disabled entirely by setting this parameter to "0". Path checking is provided to comply with "the most paranoid of paranoid" and is not free nor even cheap. With the path cache and FID cache the effect is reduced, however, it is suggested that this parameter be disabled unless a specific workload requires it.

Name: [ODS2] DATA_CACHE_ENABLE
Type: BOOLEAN
Scope: CLUSTER-WIDE
Default: 1
Description:

This parameter enables or disables the internal ODS2 data cache. This cache is used for record de-blocking of read-only files (VFC format) and as a backup to the global data cache (test mode only). If the cache is disabled the blocks will be read from disk as necessary.

Name: [ODS2] DIR_CACHE_ENABLE
Type: BOOLEAN
Scope: CLUSTER-WIDE
Default: 1
Description:

This parameter enables or disables the directory cache in ODS2. The directory cache holds the contents of directories and is used for enumerates.

The directory cache is sychronized with the XQP+ and with the XQP in a cluster. Standalone systems using the XQP can not use directory caching. This parameter will be ignored if the XQP+ is not present or if the system is not in a cluster.

Name: [ODS2] DIR_CACHE_SIZE
Type: INTEGER
Scope: CLUSTER-WIDE
Default: 256
Minimum: 4
Maximum: unlimited
Equation: MAX_CLIENT * SHARES_PER_CLIENT
Description:

This parameter controls the number of directories which will be cached. Block are allocated for the directory entries as needed. The parameter [ODS2]DIR_CACHE_MAX_BLOCKS controls the size of a directory which may be cached. The total number of blocks allocated to the directory cache is [ODS2]DIR_CACHE_SIZE * [ODS2]DIR_CACHE_MAX_BLOCKS.

Name: [ODS2] DIR_CACHE_MAX_BLOCKS
Type: Integer
Scope: CLUSTER-WIDE
Default: 32
Minimum: 4
Maximum: 256
Equation: None

This parameter controls the size of the largest directory which may be cached. Directories larger than this number (in blocks) will be accessed using direct QIOs.

Name: [ODS2] FID_CACHE_SIZE
Type: INTEGER
Scope: CLUSTER-WIDE
Default: 2048
Minimum: 256
Maximum: unlimited
Equation: MAX_OPEN_FILES * 2.5
Description:

This parameter controls the size of the file header cache, in blocks. The cache should be large enough to hold the maximum number of concurrently open files supported X 2 plus enough space for general header caching.

Name: [ODS2] F11B_FID_LOCKING
Type: BOOLEAN
Scope: CLUSTER-WIDE
Default: 0
Description:

This parameter enables or disables using F11B (XQP) locks to track host modifications to FID cache entries. This feature will only work with the XQP+ or the XQP when in a cluster.

Name: [ODS2] F11B_PATH_LOCKING
Type: BOOLEAN
Scope: CLUSTER-WIDE
Default: 1
Description:

This parameter enables or disables using the F11B (XQP) volume allocation lock as a means of detecting path modifications. This feature will work with all configurations of XQP or XQP+. This parameter should be enabled for host concurrency.

Name: [ODS2] PATH_CACHE_ENABLE

Type: BOOLEAN
Scope: CLUSTER-WIDE
Default: 1
Description:

This parameter enables or disables the ODS2 path cache. The cache holds recently translated paths and attributes associated with the path. This feature provides a very high performance gain and should be enabled at all times.

Name: [ODS2] PATH_CACHE_SIZE
Type: INTEGER
Scope: CLUSTER-WIDE
Default: 256
Minimum: 32
Maximum: unlimited
Equation: MAX_CLIENT * SHARES_PER_CLIENT * 4 (average directory depth)
Description:

This parameter controls the size of the path cache, in entries. The path cache is a process specific cache and is allocated from process memory. The size of the cache needs to be weighed against path invalidation activity. A general rule may be 20 X number of clients associated with the process.

Name: [ODS2] OK_TO_LIE
Type: BOOLEAN
Scope: CLUSTER-WIDE
Default: 1
Description:

This parameter enables or disables reading non stream files when they are open to determine the exact byte count in the file. This is obviously very slow and if the client can tolerate an estimated count this parameter should be enabled.

Name: [ODS2] CHECK_BINARY
Type: BOOLEAN
Scope: CLUSTER-WIDE
Default: 0
Description:

This parameter enables or disables scanning the first 256 characters of a newly created file to determine if it is binary or text. A file is considered binary if 20% of the first 256 characters are non-printable or if 3 CR/LF pairs are not seen. If a file is determoned to be binary, its format is converted to FIXED 512. If this parameter is disabled, all files will be created as STREAM.

Name: [ODS2] FID_TIMER_INTERVAL
Type: INTEGER
Scope: CLUSTER-WIDE
Default: 6
Minimum: 0
Maximum: 65535
Description:

This parameter controls the number of interval, in seconds, between FID cache scanning for expired entries. If this parameter is defined a "0" the mechanism is disabled. Each entry in the FID cache is given an initial count (see below) which is decremented each interval. When the count reaches 0 the entry may no longer be hit and must be fetched from disk.

Open files are aged in a similar fashion. However, they are not invalidated. Instead any modifications are written back to disk on the next reference following the expiration of the timer.

Name: [ODS2] FID_TIMER_COUNT
Type: INTEGER
Scope: CLUSTER-WIDE
Default: 5
Minimum: 0
Maximum: 65535
Description:

This parameter controls the number of intervals in which a FID cache entry may be hit. There is a very high hit rate within a short period of entering a FID cache entry. The hit rate drops off fairly quickly such that invalidation of 20 seconds or so does not decrease performance significantly. The tradeoff is long term hit rate (i.e. subsequence access to the same file). This is a workload specific variable and is difficult to predict. The short term hit rate is due to the server architecture and is very predictable.

Name: [ODS2] FID_TIMER_STACK_SIZE
Type: INTEGER
Scope: CLUSTER-WIDE
Default: 4096
Minimum: 1024
Maximum: unlimited
Description:

This parameter controls the size of the stack allocated to the FID cache timer thread. The stack must be large enough to allow delivery of ASTs while the thread is executing.

Name: [ODS2] THREAD_SWITCH_HEADER
Type: BOOLEAN
Scope: CLUSTER-WIDE
Default: 1
Description:

This parameter enables or disables thread switching on file header access. In single thread operation there is a nominal performance increase when switching is disabled. However, this parameter
should be set for all "live" server workloads.

Name: [ODS2] THREAD_SWITCH_DATA
Type: BOOLEAN
Scope: CLUSTER-WIDE
Default: 1
Description:

This parameter enables or disables thread switching on file data access. In single thread operation there is a nominal performance increase when switching is disabled. However, this parameter should be set for all "live" server workloads.

Name: [ODS2] F11B_MAX_THREAD
Type: INTEGER
Scope: CLUSTER-WIDE
Default: 8
Minimum: 0
Maximum: 8
Description:

This parameter controls the number of F11B (XQP+) threads allocated to the process. Details of this parameter are not yet known but it is felt the parameter should be set to its maximum value, 8. Non XQP+ environments ignore this parameter.

Name: [ODS2] F11B_DEFER_WRITE
Type: BOOLEAN
Scope: CLUSTER-WIDE
Default: 1
Description:

This parameter enables or disables F11B (XQP+) deferred writes. There is a significant performance advantage in seting this parameter. It should be set to "1" for all XQP+ environments. XQP+ environments ignore this parameter.

Name: [ODS2] CASE_SENSITIVE
Type: BOOLEAN
Scope: CLUSTER-WIDE
Default: 0
Description:

This parameter controls cacse-sensitive file creates in the ODS2 library. If the parameter is set all lower case letters in the filename are escaped, i.e. __XX. If the parameter is not set all lower case letters are converted to uppercase.

Name: [ODS2] EXTEND_QUANTITY
Type: INTEGER
Scope: CLUSTER-WIDE
Default: 32
Minimum: 0
Maximum: 65535
Description:

This parameter controls the number of blocks allocated to a file when it is extended. There is a tradeoff between the time taken to allocte the blocks and the number of times a file will need to be extened. The 4.x server has found this value to be optimal at 80. However, XQP+ studies have shown advantages up to 256 blocks per extend. The overall disk space waste vs file extend time needs to be considered when setting this parameter. If "0" is specified, the default extend quantity (set when the volume is initialized) is used.

Name: [ODS2] CREATE_QUANTITY
Type: INTEGER
Scope: CLUSTER-WIDE
Default: 32
Minimum: 0
Maximum: 65535
Description:

This parameter controls the number of blocks allocated to a file when it is created. There may be a performance advantage in XQP environments when the initial allocation size is high. However, it has been seen that performance is seriously degraded when using the XQP+ and modest allocation sizes (64). If the parameter is set to "0" the default extend quantity is used.

Name: [ODS2] STAT_COLLECT
Type: BOOLEAN
Scope: CLUSTER-WIDE
Default: 0
Description:

This parameter enables or disables collection of ODS2 run time statistics. These statistics count the number of functions issued and the amount of time taken by various functions. This collection is not free and degrades performance between 5-10%. This parameter should only be enabled for performance tuning related workloads.

Name: [ODS2] DEFER_WRITE
Type: BOOLEAN
Scope: CLUSTER-WIDE
Default: 1
Description:

This parameter enables or disables "ganging" of disk writes. When set all writes in a descriptor list are issued asynchronously. The completion routine for each buffer decrements the gang count and resumes the thread when 0. If the parameter is not set each buffer is written serially, allowing thread switch between based on [ODS2] THREAD_SWITCH_DATA.

Name: [ODS2] TEST_MODE
Type: BOOLEAN
Scope: CLUSTER-WIDE
Default: 0
Description:

This parameter is used for file system verification only. It should not be set for "live" workloads.

Note

This parameter forces all caches to process specific. It may be used for other internal test purposes as well.

Name: [ODS2] CLUSTER_SYNC
Type: BOOLEAN

Scope: CLUSTER-WIDE
Default: 1
Description:

This parameter enables or disables FID cache cluster wide synchronization. This parameter may be cleared to increase performance when running a standalone server in a cluster. By default, cluster synchronization is only performed when running in a cluster. This synchronization may be disabled with this parameter.

TEST_MODE	CLUSTER_SYNC	Result
0	0	Sync Disabled
0	1	Enabled if in cluster
1	0	Sync Disabled
1	1	Sync Enabled

Name: [ODS2] USE_CHANNEL_MPX
Type: BOOLEAN
Scope: CLUSTER-WIDE
Default: 1
Description:

This parameter enables ODS2 to use channel multiplexing, aka 4.x. Channel multiplexing allows more channels to be used that the SYSGEN CHANNELCNT parameter would otherwise allow. This parameter should be set for all "live" workloads.

Note

This parameter does not actually enable channel multiplexing but rather enables ODS2 to use it. Channel multiplexing is controlled with the [HOST] ENABLE_CHANNEL_MPX parameter. If channel multiplexing is disabled the calls are vectored to normal system channel functions. For this reason, ODS2 should always be configured to use channel multiplexing. This parameter is for debug purposes only.

Name: [ODS2] CHECK_RESOURCE_ID
Type: BOOLEAN
Scope: CLUSTER-WIDE
Default: 1
Description:

This parameter enables or disables checking the parent directory for ownership by a resource ID. If enabled the file or directory created will have the resource ID as the owner if the user specified holds that identifier. If disabled the file or directory is created with the owner specified.

Name: [ODS2] REPORT_RESOURCE_ID
Type: BOOLEAN
Scope: CLUSTER-WIDE
Default: 1
Description:

This parameter enables or disables checking the root directory for ownership by a resource ID. If enabled the volume size is reported as the quota established for the resource, if quotas are enabled and if the user specified holds the resource identifier. If the above fails or if the parameter is disabled the user's UIC is checked for quotas and if none set the disk allocation statistics are reported.

Name: [ODS2] GENERATE_OWNER_ACE
Type: BOOLEAN
Scope: CLUSTER-WIDE
Default: 1
Description:

This parameter enables or disables the generation of a protection ACE granting the creator access to a file owned by a resource. The parameter only has effect if [ODS2] CHECK_RESOURCE_ID is enabled and if the created file or directory is determined to be owned by a resource ID. If the parameter is dsiabled, no ACE is generated.

Name: [ODS2] EXTEND_CONTIG
Type: Boolean
Scope: CLUSTER-WIDE
Default: 1
Description:

This parameter controls file extents. When set, extents will be allocated contiguous-best-try. This reduces fragmentation as well as improving file system read/write performance.

Name: [ODS2] CREATE_CATHEDRAL
Type: Boolean
Scope: CLUSTER-WIDE
Default: 0
Description:

This parameter creates cathedral windows for initial file extents. This allows the window control block to be set up prior to deferred XQP+ header/directory writebacks. If file data writes occur during the writeback period they may proceed if the window control block is initilaized. They
will stall otherwise.

F.3 FAT File System

Name: [FAT] RESOURCE_WAIT_MODE
Type: Boolean
Scope: CLUSTER-WIDE
Default: 1
Description:

This parameter controls the action taken when resources controlled by the FAT file system are not available. If set the file system will stall until the resources become available. If clear the file system will fail.

Name: [FAT] DIR_CACHE_SIZE
Type: Integer
Scope: CLUSTER-WIDE
Default: 256

Minimum: 64
Maximim: Unlimimited
Description:

This parameter controls the size of the FAT directory cache in blocks.

Name: [FAT] DIR_HASH_SIZE
Type: Integer
Scope: CLUSTER-WIDE
Default: 0
Minimum: 0
Maximim: Unlimited
Description:

This parameter controls the hash table length for the FAT directory cache. If set to 0 the length is calculated internally.

Name: [FAT] DIR_CACHE_BLOCK_SIZE
Type: Integer
Scope: CLUSTER-WIDE
Default: 2048
Minimum: 512
Maximim: 8192
Description:

This parameters sets the size of the directory cache block in bytes. The cache block size will be rounded to the next multiple of a disk block.

Name: [FAT] FAT_CACHE_SIZE
Type: Integer
Scope: CLUSTER-WIDE
Default: 256
Minimum: 256
Maximim: Unlimited
Description:

This parameter controls the size of the FAT FAT cache in blocks.

Name: [FAT] FAT_HASH_SIZE
Type: Integer
Scope: CLUSTER-WIDE
Default: 0
Minimum: 0
Maximim: unlimited
Description:

This parameter controls the hash table length for the FAT FAT cache. If set to 0 the length is calculated internally.

Name: [FAT] FAT_CACHE_BLOCK_SIZE
Type: Integer
Scope: CLUSTER-WIDE
Default: 1536
Minimum: 1536

Maximim: Unlimited
Description:

This parameter controls the size of the FAT cache block. The value will be routined to the next multiple of 1536 to insure that 12 bit FATs will never cross block boundaries.

Name: [FAT] EXTEND_QUANTITY
Type: Integer
Scope: CLUSTER-WIDE
Default: 0
Minimum: 0
Maximim: 65535
Description:

This parameter controls the number of blocks allocated to a file when it is extended. There is a tradeoff between the time taken to allocte the blocks and the number of times a file will need to be extened. The 4.x server has found this value to be optimal at 80. However, XQP+ studies have shown advantages up to 256 blocks per extend. The overall disk space waste vs file extend time needs to be considered when setting this parameter. If "0" is specified, the extend quantity is set to the number of blocks required to satisfy a write request.

Name: [FAT] CREATE_QUANTITY
Type: Integer
Scope: CLUSTER-WIDE
Default: 0
Minimum: 0
Maximim: 65535
Description:

This parameter controls the number of blocks allocated to a file when it is created. If the parameter is set to 0 the first cluster of a file is allocated when the file is created.

Name: [FAT] MAX_CONTAINERS
Type: Integer
Scope: CLUSTER-WIDE
Default: 65535
Minimum: 1
Maximim: 65535
Description:

This parameter controls the size of the FAT container registration namespace.

Name: [FAT] DEFER_FAT_WRITES
Type: Boolean
Scope: CLUSTER-WIDE
Default: 0
Description:

This parameter controls deferred writes to the File Allocation Table. When set, writes are performed asynchronously. It is not suggested this option be used, except in the most performance critical application because there will be a window where FAT writes and directory writes may not be properly sequenced. If the system crashes during this window there may be directory entries left pointing to non allocated FAT entries. This may lead to container file corruption.

Name: [FAT] DEFER_DIR_WRITES
Type: Boolean
Scope: CLUSTER-WIDE
Default: 0
Description:

This parameter controls directory cache writebacks. If set, the writes will be done asynchronously. Setting this bit may lead to missing files in the directory if the system crashes before the directory entry is written. However, no container file corruption can occur if [FAT] DEFER_FAT_WRITES is not set. The only possibility is there will be orphan clusters allocated.

Name: [FAT] DEFER_IO_WRITES
Type: Boolean
Scope: CLUSTER-WIDE
Default: 0
Description:

This parameter controls writes to normal data blocks in the container file. It is not currently used.

Name: [FAT] STAT_COLLECT
Type: Boolean
Scope: CLUSTER-WIDE
Default: 0
Description:

This parameter enables collection of file system statistics. It is used for debug only.

F.4 DEBUG Facility

Name: [DEBUG] LIB_TRACE_MEMORY
Type: BOOLEAN
Scope: CLUSTER-WIDE
Default: 0
Description:

This parameter enables or disables logging of each memory allocation and release. It should normally be set to "0".

Name: [DEBUG] LIB_TRACK_MEMORY
Type: BOOLEAN
Scope: CLUSTER-WIDE
Default: 0
Description:

This parameter enables or diables tracking of each memory allocation and release. Each memory allocation contains an additional header and is queued to an "inuse" queue along with a string describing the memory and a class of allocation. The queue may be displayed to determine if all memory allocated during a test has been released. This parameter is for test use only and should normally be set to "0".

F.5 Channel Multiplexing

Name: [HOST] RESERVED_CHANNELS
Type: INTEGER
Scope: CLUSTER-WIDE
Default: 500
Minimum: 10
Maximum: 2047
Description:

This parameter is the mimimum number of channels to reserve for non-multiplexed use. Typical values would be between 30 and 60 depending on the number of server specific files which can be open simultaneously, number of global sections backed by a separate page file, log files, etc. PFS will use the remainder (SYSGEN param CHANNELCNT - [HOST] RESERVED_CHANNELS) for multiplexing client file open requests.

Note

This parameter is fixed in the V4 server. Since Hydra has many more non-multiplexed files than does V4 and the front end server itself is variable, this count needs to be variable.

Name: [HOST] ENABLE_CHANNEL_MPX
Type: BOOLEAN
Scope: CLUSTER-WIDE
Default: 1
Description:

Enable channel multiplexing. By default, all PW_xxx calls use normal direct IO. When channel multiplexing is enabled, the call use PATHWORKS extended channels.

Networks Engineering Services

END OF JOB

LKG2P1::RANGER::BRADLEY

JOB 431

PFS_FUNCTIONAL_SPEC_BL4

```
20-APR-1994 17:00  %DCPS-W-UNDEF, undefined: Name not known - offending command i
s nt
20-APR-1994 17:00  %DCPS-E-FLUSHING, Rest of Job (to EOJ) will be ignored
```

Owner UIC:	**[DQS$SERVER]**
Account:	**TOOTER::**

Priority:	100
Submit queue:	LKG21_04
Submitted:	20-APR-1994 16:04
Printer queue:	LKG21_04
Printer device:	4LPS04
Started:	20-APR-1994 16:29
Finished:	20-APR-1994 17:00
Qualifiers:	/FORM=CPS$DEFAULT /FLAG
Parameters:	DATA_TYPE=POSTSCRIPT, PAGE_SIZE=A, SHEET_SIZE=A
Sheets printed:	146

Digital Equipment Corporation **PrintServer 20 4LPS04**

OpenVMS VAX system V5.5–2 DECprint Supervisor V1.0B