# [MS-FSA]:
# File System Algorithms

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## Revision Summary

| Date | Revision History | Revision Class | Comments |
|---|---|---|---|
| 03/12/2010 | 0.1 | Major | First Release. |
| 04/23/2010 | 0.1.1 | Editorial | Revised and edited the technical content. |
| 06/04/2010 | 1.0 | Major | Updated and revised the technical content. |
| 07/16/2010 | 2.0 | Major | Significantly changed the technical content. |
| 08/27/2010 | 3.0 | Major | Significantly changed the technical content. |
| 10/08/2010 | 4.0 | Major | Significantly changed the technical content. |
| 11/19/2010 | 5.0 | Major | Significantly changed the technical content. |
| 01/07/2011 | 6.0 | Major | Significantly changed the technical content. |
| 02/11/2011 | 6.0 | No change | No changes to the meaning, language, or formatting of the technical content. |

# Contents

# 1   Introduction

This document defines an abstract model for how an object store can be implemented to support the Common Internet File System (CIFS) Protocol, the Server Message Block (SMB) Protocol and the Server Message Block (SMB) Version 2 Protocol (described in [MS-CIFS], [MS-SMB] and [MS-SMB2], respectively).

## 1.1   Glossary

The following terms are defined in [MS-FSCC]:

**cluster**

The following terms are defined in [MS-GLOS]:

**volume**
**globally unique identifier (GUID)**
**mount point**
**reparse point**
**server**
**SID**
**symbolic link**
**Unicode**

The following terms are specific to this document:

**Alternate Data Stream:** A named data stream that is part of a file or directory, which can be opened independently of the **default data stream**. Many operations on an alternate data stream affect only that stream and not other streams or the file or directory as a whole.

**Backup:** The act of copying data (usually files) to some other storage media in case of equipment failure or other catastrophic event.

**Compression Unit:** A segment of a stream that the object store can compress, encrypt, or make sparse independently of other segments of the same stream.

**Default Data Stream:** The unnamed data stream in a non-directory file. Many operations on a default data stream affect the file as a whole.

**Restore:** The act of copying data (usually files) back to its original storage location from some other storage media after some form of data loss.

**Software Defect Management:** A mechanism for the object store to manage and remap defective blocks on removable rewritable media (such as CD-RW, DVD-RW, and DVD+RW).<1>

**WinPE:** Windows Pre-installation Environment.

**MAY, SHOULD, MUST, SHOULD NOT, MUST NOT:** These terms (in all caps) are used as described in [RFC2119]. All statements of optional behavior use either MAY, SHOULD, or SHOULD NOT.

## 1.2 References

### 1.2.1 Normative References

We conduct frequent surveys of the normative references to assure their continued availability. If you have any issue with finding a normative reference, please contact dochelp@microsoft.com. We will assist you in finding the relevant information. Please check the archive site, http://msdn2.microsoft.com/en-us/library/E4BD6494-06AD-4aed-9823-445E921C9624, as an additional source.

[MS-DTYP] Microsoft Corporation, "Windows Data Types", January 2007.

[MS-ERREF] Microsoft Corporation, "Windows Error Codes", January 2007.

[MS-FSCC] Microsoft Corporation, "File System Control Codes", July 2007.

[MS-LSAD] Microsoft Corporation, "Local Security Authority (Domain Policy) Remote Protocol Specification", June 2007.

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997, http://www.ietf.org/rfc/rfc2119.txt

[RFC4122] Leach, P., Mealling, M., and Salz, R., "A Universally Unique Identifier (UUID) URN Namespace", RFC 4122, July 2005, http://www.ietf.org/rfc/rfc4122.txt

### 1.2.2 Informative References

[FSBO] Microsoft Corporation, "File System Behavior in the Microsoft Windows Environment", June 2008, http://download.microsoft.com/download/4/3/8/43889780-8d45-4b2e-9d3a-c696a890309f/File%20System%20Behavior%20Overview.pdf

[MS-CIFS] Microsoft Corporation, "Common Internet File System (CIFS) Protocol Specification", September 2009.

[MS-GLOS] Microsoft Corporation, "Windows Protocols Master Glossary", March 2007.

[MS-SMB] Microsoft Corporation, "Server Message Block (SMB) Protocol Specification", July 2007.

[MS-SMB2] Microsoft Corporation, "Server Message Block (SMB) Version 2 Protocol Specification", July 2007.

[SIS] Microsoft Corporation, "Single Instance Storage in Microsoft Windows Storage Server 2003 R2", May 2006, http://www.microsoft.com/technet/itshowcase/content/sistwp.mspx

## 1.3 Overview

None.

## 1.4 Relationship to Other Protocols

None.

## 1.5 Prerequisites/Preconditions

None.

## 1.6 Applicability Statement

None.

## 1.7 Versioning and Capability Negotiation

None.

## 1.8 Vendor-Extensible Fields

This algorithm uses NTSTATUS values as defined in [MS-ERREF] section 2.3. Vendors are free to choose their own values for this field, as long as the C bit (0x20000000) is set, indicating it is a customer code.

## 1.9 Standards Assignments

## 2  Messages

This is an algorithms document describing wire-visible behavior of a backing object store that is referenced by the following protocol documents:

- The Common Internet File System (CIFS) Protocol Specification [MS-CIFS]

- The Server Message Block (SMB) Protocol Specification [MS-SMB]

- The Server Message Block (SMB) Version 2 Protocol Specification [MS-SMB2]

# 3   Algorithm Details

## 3.1   Object Store Details

### 3.1.1   Abstract Data Model

This section describes a conceptual model of possible data organization that an implementation maintains to participate in this algorithm. The described organization is provided to facilitate the explanation of how the algorithm behaves. This document does not mandate that implementations adhere to this model as long as their external behavior is consistent with that described in this document.

The following abstract object types are defined in this document:

**Volume**

**TunnelCacheEntry**

**File**

**Link**

**Stream**

**Open**

**ByteRangeLock**

**ChangeNotifyEntry**

**NotifyEventEntry**

**Oplock**

**RHOpContext**

**CancelableOperations**

**SecurityContext**

The following shorthand forms are also used:

> **DataFile:** A **File** object with a FileType of DataFile.
>
> **DirectoryFile:** A **File** object with a FileType of DirectoryFile.
>
> **DataStream:** A **Stream** object with a StreamType of DataStream.
>
> **DirectoryStream:** A **Stream** object with a StreamType of DirectoryStream.

Plural forms of all these object types are also used.

#### 3.1.1.1   Per Volume

The object store MUST implement the following persistent attributes:

- **RootDirectory:** The **DirectoryFile** for the root of this **volume**.

- **TotalSpace:** A 64-bit unsigned integer specifying the total size of the volume in bytes. This value MUST be a multiple of **ClusterSize**.

- **FreeSpace:** A 64-bit unsigned integer specifying the available space of the volume in bytes. This value MUST be a multiple of **ClusterSize**.

- **IsReadOnly:** A Boolean that is TRUE if the volume is read-only and MUST NOT be modified; otherwise, the volume is both readable and writable.

- **IsQuotasSupported:** A Boolean that is TRUE if the physical media format for this volume supports Quotas.

- **IsObjectIDsSupported:** A Boolean that is TRUE if the physical media format for this volume supports ObjectIDs.

- **IsReparsePointsSupported:** A Boolean that is TRUE if the physical media format for this volume supports ReparsePoints.

- **VolumeLabel:** A 16-character **Unicode** string containing the name of the volume. An empty value is supported.

- **SectorSize:** A 32-bit unsigned integer specifying the size of a sector for this volume in bytes. Sector size MUST be a power of 2 and MUST be greater than or equal to 512 and less than or equal to 4,096.

- **ClusterSize:** A 32-bit unsigned integer specifying the size of a **cluster** for this volume in bytes. ClusterSize MUST be a power of 2, and MUST be greater than or equal to **SectorSize** and a power of 2 multiple of **SectorSize**.<2>

- **VolumeCreationTime:** The time the volume was formatted in the FILETIME format specified in [MS-FSCC] section 2.1.1.

- **VolumeSerialNumber:** A 32-bit unsigned integer that contains a number, randomly generated at format time, to uniquely identify the volume.

- **VolumeCharacteristics:** A bit field identifying various characteristics about the current volume as specified in [MS-FSCC] section 2.5.9.

- **CompressionUnitSize:** A 32-bit unsigned integer specifying the **compression unit** size in bytes, which is the granularity used when compressing, encrypting, or sparsifying portions of a stream independent of other portions of the same stream. Not all file systems support these features, and implementation of this field is optional. If one or more of these features are supported, the value of this field is implementation-defined but MUST be a power of 2 multiple of **ClusterSize**.<3>

- **CompressedChunkSize:** A 32-bit unsigned integer specifying the maximum size of each chunk in a compressed stream. Not all file systems support compression, and implementation of this field is optional. If compression is supported, the value of this field is implementation-defined but MUST be a power of 2 and MUST be less than or equal to **CompressionUnitSize**.<4>

- **TunnelCacheList:** A list of zero or more **TunnelCacheEntries** providing metadata about recently deleted or renamed files. The list MAY be empty if the object store does not implement tunnel caching or if there are no recently deleted or renamed files on this volume.

- **ChangeNotifyList:** A list of zero or more **ChangeNotifyEntries** describing outstanding change notify requests for the volume.

- **GenerateShortNames:** A Boolean that is TRUE if short name creation support is enabled on this Volume. FALSE if short name creation is not supported on this Volume.

- **QuotaInformation:** A list of FILE_QUOTA_INFORMATION elements (per [MS-FSCC] section 2.4.33) that track the total **Stream.AllocationSize** per SID where the **File.SecurityDescriptor.Owner** field is equal to the SID.

- **DefaultQuotaThreshold:** A 64-bit signed integer that contains the default per-user disk quota warning threshold in bytes. Not all file systems support this field, and implementation of this field is optional.

- **DefaultQuotaLimit:** A 64-bit signed integer that contains the default per-user disk quota limit in bytes. Not all file systems support this field, and implementation of this field is optional.

- **VolumeQuotaState:** A bitmask of flags defining the current quota state on the volume as specified in [MS-FSCC] section 2.5.2 under FileSystemControlFlags. Not all file systems support this field, and implementation of this field is optional.

- **VolumeId:** A **GUID** as specified in [RFC4122]. This value MAY be NULL.

- **ExtendedInfo:** A 48-byte structure containing extended VolumeId information, as described in [MS-FSCC] section 2.5.6.<5>

- **IsUsnJournalActive:** A Boolean that is TRUE if a USN change journal is active on the volume.<6>

- **LastUsn:** A 64-bit unsigned integer indicating the positive USN number of the last record written to the USN change journal on the volume, or 0 if no USN records have been written. If **IsUsnJournalActive** is FALSE, **LastUsn** MUST be 0.

The following fields are specific to UDF object stores:

- **DirectoryCount:** A 64-bit signed integer that indicates the count of directories on the volume, or -1 if not maintained by the object store.

- **FileCount:** A 64-bit signed integer that indicates the count of files on the volume, or -1 if not maintained by the object store.

- **FsFormatMajVersion:** A 16-bit unsigned integer indicating the major version of the file system format.

- **FsFormatMinVersion:** A 16-bit unsigned integer indicating the minor version of the file system format.

- **FormatTime:** The time the volume was formatted in the FILETIME format specified in [MS-FSCC] section 2.1.1.

- **LastUpdateTime:** The time the volume was last updated in the FILETIME format specified in [MS-FSCC] section 2.1.1.

- **CopyrightInfo:** A 68-byte buffer containing any copyright info associated with the volume.

- **AbstractInfo:** A 68-byte buffer containing any abstract info associated with the volume.

- **FormattingImplementationInfo:** A 68-byte buffer containing implementation-specific information; this field MAY contain the operating system version that the media was formatted by.

- **LastModifyingImplementationInfo:** A 68-byte buffer containing information written by the last implementation that modified the disk. This field is implementation-specific and MAY contain the operating system version that the media was last modified by.

- **SparingUnitBytes:** A 32-bit unsigned integer indicating the size in bytes of a sparing unit.

- **SoftwareSparing:** A Boolean that is TRUE if the volume's bad block sparing mechanism is implemented in software, FALSE if bad block sparing is implemented by the underlying hardware this volume is on.

- **TotalSpareBlocks:** A 32-bit unsigned integer indicating the total number of spare blocks.

- **FreeSpareBlocks:** A 32-bit unsigned integer indicating the available number of spare blocks.

Volatile Fields:

- **OpenFileList:** A list of all the **File** objects opened on **Volume**.

### 3.1.1.2 Per TunnelCacheEntry

Implementation of tunnel caching is optional. If case-sensitive file name matching is enabled (for example, for POSIX compliance), the object store SHOULD NOT implement tunnel caching. If the object store implements tunnel caching, it MUST implement the following attributes in each **TunnelCacheEntry**:

- **EntryTime:** The time at which this **TunnelCacheEntry** was created. The object store SHOULD use this attribute to automatically purge this entry from the tunnel cache once the entry is 15 seconds old.

- **ParentFile:** The parent **DirectoryFile** that this **TunnelCacheEntry** refers to.

- **FileName:** A Unicode string specifying the long name of the file. This string MUST be greater than 0 characters and less than 256 characters in length. Valid characters for a file name are specified in [MS-FSCC] section 2.1.5.

- **FileShortName:** A Unicode string specifying the short name of the file. This string MAY be empty if **KeyByShortName** is FALSE. If non-empty, it MUST be 8.3-complaint as described in [MS-FSCC] section 2.1.5.2.1.

- **KeyByShortName:** A Boolean that is TRUE when **FileShortName** is used as the key for this entry. FALSE when **FileName** is used as the key for this entry.

- **FileCreationTime:** The time that identifies when the file was created in the FILETIME format specified in [MS-FSCC] section 2.1.1.

- **FileObjectId:** A GUID as specified in [RFC4122]. This value can be NULL. If non-NULL, this value MUST be unique on a given volume.

### 3.1.1.3 Per File

The object store MUST implement the following persistent attributes:

- **FileType:** The type of file. This value MUST be either DataFile or DirectoryFile.

- **FileID:** A 64-bit unsigned integer that identifies the file. This value MUST be persistent and MUST be unique on a given volume.

- **LinkList:** A list of one or more **Links** to the file. A DirectoryFile MUST have exactly one element in **LinkList**. **LinkList** MUST have at most one element with a non-empty **ShortName**.

- **SecurityDescriptor:** The security descriptor for this file, in the format specified in [MS-DTYP] section 2.4.6.

- **FileAttributes:** Attributes of the file in the form specified in [MS-FSCC] section 2.6.

- **CreationTime:** The time that identifies when the file was created in the FILETIME format specified in [MS-FSCC] section 2.1.1.<7>

- **LastModificationTime:** The time that identifies when the file contents were last modified in the FILETIME format specified in [MS-FSCC] section 2.1.1.<8>

- **LastChangeTime:** The time that identifies when the file metadata or contents were last changed in the FILETIME format specified in [MS-FSCC] section 2.1.1.<9>

- **LastAccessTime:** The time that identifies when the file was last accessed in the FILETIME format specified in [MS-FSCC] section 2.1.1. Updating this value when accesses occur is optional.<10><11>

- **ExtendedAttributes:** A list of FILE_FULL_EA_INFORMATION structures as defined by MS-FSCC section 2.4.15.

- **ExtendedAttributesLength:** A 32-bit unsigned integer that contains the combined length of all the **ExtendedAttributes**.

- **ObjectId:** A GUID as specified in [RFC4122]. This value can be NULL. If set to non-NULL, this value MUST be unique on a given volume.

- **BirthVolumeId**: A GUID that uniquely identifies the volume on which the object resided when the object identifier was created, or zero if the volume had no object identifier at that time. After copy operations, move operations, or other file operations, this value is potentially different from the **VolumeId** of the volume on which the object currently resides.

- **BirthObjectId**: A GUID value containing the object identifier of the object at the time it was created. After copy operations, move operations, or other file operations, this value is potentially different from the ObjectId member at present.

- **StreamList:** A list of zero or more **Streams** as defined in section 3.1.1.4. A DataFile MUST have one and only one unnamed DataStream; any additional streams MUST be named DataStreams. A DirectoryFile MUST have one and only one DirectoryStream named "$I30"; any additional streams MUST be named DataStreams. For any two distinct elements *Stream1* and *Stream2* in **StreamList**, if *Stream1*.**StreamType** equals *Stream2*.**StreamType** then *Stream1*.**Name** MUST NOT match *Stream2*.**Name**.

- **ReparseTag:** A 32-bit unsigned integer containing the type of the **reparse point**, as defined in [MS-FSCC] section 2.1.2.1. This member may be empty, in which case there is no ReparsePoint associated with this File.

- **ReparseGUID:** A GUID indicating the type of the reparse point. This field MUST contain a valid GUID if **ReparseTag** contains a non-Microsoft tag as described in [MS-FSCC] section 2.1.2.1. Otherwise it MUST be empty.

- **ReparseData:** An array of bytes containing data associated with a reparse point, which is defined by the type of the reparse point, as described in [MS-FSCC] sections 2.1.2.1 through 2.1.3.2. If ReparseTag is empty, this member MUST be empty. If ReparseTag is not empty, this

member MAY be empty, in which case there is no Reparse data associated with this reparse point.

- **DirectoryList:** For a DataFile, this list MUST be empty. For a DirectoryFile, this is a list of **Links** contained in the directory. For any two distinct elements *Link1* and *Link2* in **DirectoryList**, *Link1*.**Name** MUST NOT match *Link2*.**Name** or *Link2*.**ShortName**.

- **Volume:** The **Volume** on which the file resides.

- **Usn:** A 64-bit unsigned integer indicating the positive USN number of the last USN record written for this file, or 0 if no USN records have been written for this file.

- **IsSymbolicLink:** A Boolean that is TRUE if the file is a **mount point** or a **symbolic link** to another file or directory.

- **UserCertificateList:** A list of **ENCRYPTION_CERTIFICATE** structures as specified in [MS-EFSR] section 2.2.8, used to determine which users can access the contents of any encrypted streams in the file.

Volatile Fields:

- **OpenList:** A list of all **Opens** to this **File**.

- **PendingNotifications:** A 32-bit unsigned integer composed of flags indicating types of changes to file attributes for which directory change notifications are pending, as specified in [MS-SMB2] section 2.2.35, **CompletionFilter** field.

### 3.1.1.4  Per Link

The object store MUST implement the following persistent attributes:

- **Name:** A Unicode string specifying the name of the link. This string MUST be greater than 0 characters and less than 256 characters in length. Valid form for a link name is the same as the pathname specification in [MS-FSCC] section 2.1.5.

- **ShortName:** A Unicode string specifying the short name of the link. This value MAY be empty. If non-empty, it MUST be 8.3-compliant as described in [MS-FSCC] section 2.1.5.2.1.

- **File:** The **File** that this link refers to.

- **ParentFile:** The parent **DirectoryFile** that this link resides in.

- **IsDeleted:** A Boolean that is TRUE if there is a pending delete operation on the link. New opens to the associated Stream MUST NOT be allowed.

Volatile Fields:

- **PendingNotifications:** A 32-bit unsigned integer composed of flags indicating types of changes to link attributes for which directory change notifications are pending, as specified in [MS-SMB2] section 2.2.35, **CompletionFilter** field.

### 3.1.1.5  Per Stream

The object store MUST implement the following persistent attributes:

- **StreamType:** The type of stream. This value MUST be either DataStream or DirectoryStream.

- **Name:** A Unicode string of less than 256 characters specifying the name of the stream. Valid characters for a stream name are specified in [MS-FSCC] section 2.1.5. If **StreamType** is DataStream, **Name** MAY be empty, indicating the **default data stream**. If **StreamType** is DirectoryStream, **Name** MUST be empty.

- **Size:** A 64-bit unsigned integer containing the size of the stream, in bytes.

- **AllocationSize:** A 64-bit unsigned integer containing the size, in bytes, of space reserved on the disk. This value MUST be a multiple of **File.Volume.ClusterSize**.

- **ValidDataLength:** A 64-bit unsigned integer containing the size, in bytes, of valid data in the stream. Not all file systems support this field, and implementation of this field is optional. If implemented, all data beyond this value MUST be returned as zero. For a DataStream, this value MUST be less than or equal to **Size**. For a DirectoryStream, this value MUST be equal to **Size**.

- **File:** The **File** in which the stream resides.

- **IsCompressed:** A Boolean that is TRUE if the contents of the stream are compressed.

- **IsSparse:** A Boolean that is TRUE if the object store is storing a sparse representation of the stream.

- **IsTemporary:** A Boolean that is TRUE if the object store optimizes its management of the stream because it is pending deletion.

- **IsEncrypted:** A Boolean that is TRUE if the contents of the stream are encrypted.

- **ExtentList:** A list containing zero or more EXTENTS elements as defined by [MS-FSCC] section 2.3.20.1, ordered by **NextVcn**.

Volatile Fields:

- **Oplock:** An **Oplock** describing the opportunistic lock state of the stream. **Oplock** MAY be empty, in which case there is no opportunistic lock on the stream.

- **ByteRangeLockList:** A list of zero or more **ByteRangeLocks** describing the bytes ranges of this stream that are currently locked.

- **IsDeleted:** A Boolean that is TRUE if there is a pending delete operation on the **Stream**. New opens to **Stream** MUST NOT be allowed.

- **IsDefectManagementDisabled:** A Boolean that is TRUE if **software defect management** is disabled on this stream. Not all file systems support this field; implementation of this field is optional.

- **PendingNotifications:** A 32-bit unsigned integer composed of flags indicating types of changes to stream attributes for which directory change notifications are pending, as specified in [MS-SMB2] section 2.2.35, **CompletionFilter** field.

- **ZeroOnDeallocate:** A Boolean that is TRUE when the object store MUST write zeroes to any range of the stream that is to be deallocated, prior to performing the deallocation. This helps to protect whatever data may have been in the stream from discovery by examining free space on the storage media. Not all file systems support this field, and implementation of this field is optional.

### 3.1.1.6  Per Open

The object store MUST implement the following:

- **RootOpen:** The **Open** that represents the root of the share.

- **FileName:** The absolute pathname of the opened file in the format specified in [MS-FSCC] section 2.1.5.

- **File:** The **File** that is opened.

- **Link:** The **Link** through which **File** is opened. **Link** MUST be an element of **File.LinkList**.

- **Stream:** The **Stream** that is opened. **Stream** MUST be an element of **File.StreamList**.

- **GrantedAccess:** The access granted for this open as specified in [MS-SMB2] section 2.2.13.1.

- **RemainingDesiredAccess:** The access requested for this Open but not yet granted, as specified in [MS-SMB2] section 2.2.13.1.

- **SharingMode:** The sharing mode for this Open as specified in [MS-SMB2] section 2.2.13.

- **Mode:** The mode flags for this Open as specified in [MS-FSCC] section 2.4.24.

- **IsCaseInsensitive:** A Boolean that is TRUE if this Open should be treated as case-insensitive.

- **HasBackupAccess:** A Boolean that is TRUE if the Open was performed by a user who is allowed to perform **backup** operations.

- **HasRestoreAccess:** A Boolean that is TRUE if the Open was performed by a user who is allowed to perform **restore** operations.

- **HasCreateSymbolicLinkAccess:** A Boolean that is TRUE if the Open was performed by a user who is allowed to create symbolic links.

- **HasManageVolumeAccess:** A Boolean that is TRUE if the Open was performed by a user who is allowed to manage the volume.

- **IsAdministrator:** A Boolean that is TRUE if the Open was performed by a user who is a member of the BUILTIN_ADMINISTRATORS group as specified in [MS-DTYP] section 2.4.2.4.

- **QueryPattern:** The Unicode string containing the query pattern used to filter directory query.

- **QueryLastEntry:** The last **Link** that was returned in a directory query.

- **LastQuotaId:** The index of the last SID returned during quota enumeration on this Open, or -1 if there has not been a quota enumeration on this Open.

- **CurrentByteOffset:** The byte offset immediately following the most recent successful synchronous read or write operation of one or more bytes, or 0 if there have not been any.

- **FindBySidRestartIndex:** The starting index for a FSCTL_FILE_FILES_BY_SID operation.

- **UserSetModificationTime:** A Boolean that is TRUE if a user has explicitly set **File.LastModificationTime** through this Open.

- **UserSetChangeTime:** A Boolean that is TRUE if a user has explicitly set **File.LastChangeTime** through this Open.

- **UserSetAccessTime:** A Boolean that is TRUE if a user has explicitly set **File.LastAccessTime** through this Open.

- **NextEaEntry:** Contains a reference to the next FILE_FULL_EA_INFORMATION entry in **File.ExtendedAttributes** to be returned the next time FileFullEaInformation is called using this Open as defined in section 3.1.5.11.12.

- **OplockKey:** A GUID value that may be used to identify the owner of the **Open** for the purpose of determining whether to break an oplock in response to a request delivered on a particular **Open**. Requests on an **Open** whose **Open.OplockKey** value matches the **Open.OplockKey** value associated with an oplock that exists on the **Stream** do not affect the oplock state (that is, do not cause the oplock to break). This value MAY be empty for a given **Open**. If it is empty, its value MUST be considered to not match anything other than itself. In other words, if given two **Opens** *Open1* and *Open2* such that *Open1*.**OplockKey** and/or *Open2*.**OplockKey** are empty, *Open1*.**OplockKey** MUST NOT be considered equal to *Open2*.**OplockKey**.

### 3.1.1.7   Per ByteRangeLock

- **LockOffset:** A 64-bit unsigned integer specifying the offset, in bytes, from the beginning of a stream where the locked range begins.

- **LockLength:** A 64-bit unsigned integer specifying the length, in bytes, of the locked range.

- **IsExclusive:** A Boolean that is TRUE if this is an exclusive byte range lock, else FALSE if this is a shared byte range lock.

- **OwnerOpen:** The **Open** that owns this **ByteRangeLock**.

### 3.1.1.8   Per ChangeNotifyEntry

- **OpenedDirectory:** The **Open** of the **DirectoryFile** to monitor for changes.

- **WatchTree:** A Boolean value, set to TRUE if changes to subdirectories MUST be notified, FALSE if not.

- **CompletionFilter:** A 32-bit unsigned integer composed of flags indicating the types of changes to monitor as specified in [MS-SMB2] section 2.2.35.

- **NotifyEventList:** A list of **NotifyEventEntries**, representing change events that were not yet reported to the user.

### 3.1.1.9   Per NotifyEventEntry

- **Action:** A 32-bit unsigned integer composed of flags indicating the type of change events that occurred, as specified in [MS-SMB2] section 2.2.36.1.

- **FileName:** Pathname relative to **ChangeNotifyEntry.OpenedDirectory** of the file involved in the change event.

### 3.1.1.10   Per Oplock

- **ExclusiveOpen:** The **Open** used to request the opportunistic lock.

- **IIOplocks:** A list of zero or more **Opens** used to request a LEVEL_TWO opportunistic lock, as specified in section 3.1.5.17.1.

- **ROplocks:** A list of zero or more **Opens** used to request a LEVEL_GRANULAR(**RequestedOplockLevel**: READ_CACHING) opportunistic lock, as specified in section 3.1.5.17.1.

- **RHOplocks:** A list of zero or more **Opens** used to request a LEVEL_GRANULAR(**RequestedOplockLevel**: (READ_CACHING|HANDLE_CACHING)) opportunistic lock, as specified in section 3.1.5.17.1.

- **RHBreakQueue**: A list of zero or more **RHOpContext** objects. This queue is used to track (READ_CACHING|HANDLE_CACHING) oplocks as they are breaking.

- **WaitList:** A list of zero or more **Opens** belonging to operations that are waiting for an oplock to break, as specified in section 3.1.4.12.

- **State:** The current state of the oplock, expressed as a combination of one or more flags. Valid flags are:

  - NO_OPLOCK - Indicates that this **Oplock** does not represent a currently granted or breaking oplock. This is semantically equivalent to the **Oplock** object being entirely absent from a **Stream**. This flag always appears alone.

  - LEVEL_ONE_OPLOCK - Indicates that this **Oplock** represents a Level 1 (also called Exclusive) oplock.

  - BATCH_OPLOCK - Indicates that this **Oplock** represents a Batch oplock.

  - LEVEL_TWO_OPLOCK - Indicates that this **Oplock** represents a Level 2 (also called Shared) oplock.

  - EXCLUSIVE - Indicates that this **Oplock** represents an oplock that can be held by exactly one client at a time. This flag always appears in combination with other flags that indicate the actual oplock level. For example, (READ_CACHING|WRITE_CACHING|EXCLUSIVE) represents a read caching and write caching oplock, which can be held by only one client at a time.

  - BREAK_TO_TWO - Indicates that this **Oplock** represents an oplock that is currently breaking from either Level 1 or Batch to Level 2; the oplock has broken but the break has not yet been acknowledged.

  - BREAK_TO_NONE - Indicates that this **Oplock** represents an oplock that is currently breaking from either Level 1 or Batch to None (that is, no oplock); the oplock has broken but the break has not yet been acknowledged.

  - BREAK_TO_TWO_TO_NONE - Indicates that this **Oplock** represents an oplock that is currently breaking from either Level 1 or Batch to None (that is, no oplock), and was previously breaking from Level 1 or Batch to Level 2; the oplock has broken but the break has not yet been acknowledged.

  - READ_CACHING - Indicates that this **Oplock** represents an oplock that provides caching of reads; this provides the SMB 2.1 read caching lease, as described in [MS-SMB2] section 2.2.13.2.8.

  - HANDLE_CACHING - Indicates that this **Oplock** represents an oplock that provides caching of handles; this provides the SMB 2.1 handle caching lease, as described in [MS-SMB2] section 2.2.13.2.8.

- WRITE_CACHING - Indicates that this **Oplock** represents an oplock that provides caching of writes; this provides the SMB 2.1 write caching lease, as described in [MS-SMB2] section 2.2.13.2.8.

- MIXED_R_AND_RH - Always appears together with READ_CACHING and HANDLE_CACHING. Indicates that this **Oplock** represents an oplock on which at least one client has been granted a read caching oplock, and at least one other client has been granted a read caching and handle caching oplock.

- BREAK_TO_ READ_CACHING - Indicates that this **Oplock** represents an oplock that is currently breaking to an oplock that provides caching of reads; the oplock has broken but the break has not yet been acknowledged.

- BREAK_TO_WRITE_CACHING - Indicates that this **Oplock** represents an oplock that is currently breaking to an oplock that provides caching of writes; the oplock has broken but the break has not yet been acknowledged.

- BREAK_TO_HANDLE_CACHING - Indicates that this **Oplock** represents an oplock that is currently breaking to an oplock that provides caching of handles; the oplock has broken but the break has not yet been acknowledged.

- BREAK_TO_NO_CACHING - Indicates that this **Oplock** represents an oplock that is currently breaking to None (that is, no oplock); the oplock has broken but the break has not yet been acknowledged.

### 3.1.1.11 Per RHOpContext

- **Open:** The **Open** used to request this LEVEL_GRANULAR(**RequestedOplockLevel**: (READ_CACHING|HANDLE_CACHING)) opportunistic lock.

- **BreakingToRead:** A Boolean value that is TRUE if this oplock is breaking to READ_CACHING, FALSE if it is breaking to None (that is, no oplock; the oplock is being broken completely).

### 3.1.1.12 Per CancelableOperations

- **CancelableOperationList**: A global list of cancelable operations currently being processed by the object store. Items in this list are looked up via their **IORequest** Identifier as defined in section 3.1.5.19. Operations are inserted into this list when a cancelable operation waits.

### 3.1.1.13 Per SecurityContext

- **SIDs:** An array of SID structures, as specified in [MS-DTYP] section 2.4.2, representing the security identifier of the user performing an operation and the security identifiers of all groups of which the user is a member.

- **OwnerIndex:** An index into **SIDs** indicating the SID of the user.

- **PrimaryGroup:** An index into **SIDs** indicating the SID of the user's primary group.

- **DefaultDACL:** An ACL structure, as specified in [MS-DTYP] section 2.4.5, representing the default DACL assigned to new files created by the user.

- **PrivilegeSet:** A set of privilege names, as specified in [MS-LSAD] section 3.1.1.2.1, representing the privileges held by the user.

### 3.1.2 Timers

The object store has no timers.

### 3.1.3 Initialization

On initialization, one or more **Volume** objects are initialized based on the data stored in the persistent store. This involves instantiating one or more **File** objects contained within the volume.

### 3.1.4 Common Algorithms

This section describes internal algorithms that are common across multiple triggered events.

#### 3.1.4.1 Algorithm for Reporting a Change Notification for a Directory

The inputs for this algorithm are:

- **Volume:** The volume this event occurs on.

- **Action:** A 32-bit unsigned integer describing the action that caused the change events to be notified, as specified in [MS-SMB2] section 2.2.36.1.

- **FilterMatch:** A 32-bit unsigned integer field with flags representing possible change events, corresponding to a **ChangeNotifyEntry.CompletionFilter**. It is specified in [MS-SMB2] section 2.2.35.

- **FileName:** The pathname, relative to **Volume.RootDirectory**, of the file involved in the change event.

Pseudocode for the algorithm is as follows:

- For each **ChangeNotifyEntry** in **Volume.ChangeNotifyList**:

  - Initialize *SendNotification* to FALSE.

  - If **ChangeNotifyEntry.OpenedDirectory.File** matches the **File** whose pathname is **FileName** or matches the immediate parent of this **File** and one or more of the flags in **FilterMatch** are present in **ChangeNotifyEntry.CompletionFilter**, then *SendNotification* MUST be set to TRUE.

  - Else If **ChangeNotifyEntry.WatchTree** is TRUE and **ChangeNotifyEntry.OpenedDirectory.File** matches an ancestor of the **File** whose pathname is **FileName** and one or more of the flags in **FilterMatch** are present in **ChangeNotifyEntry.CompletionFilter**, then *SendNotification* MUST be set to TRUE.

  - EndIf

  - If *SendNotification* is TRUE:

    - A **NotifyEventEntry** object MUST be constructed with:

      - **NotifyEventEntry.Action** set to **Action**.

      - **NotifyEventEntry.FileName** set to the portion of **FileName** relative to **ChangeNotifyEntry.OpenedDirectory.FileName**.

    - Insert **NotifyEventEntry** into **ChangeNotifyEntry.NotifyEventList**.

- Processing will be performed as described in section 3.1.5.10.1.

- EndIf

- EndFor

## 3.1.4.2 Algorithm for Detecting If Open Files Exist Within a Directory

The inputs for this algorithm are:

- **File:** The DirectoryFile we inspect for open files.

- **Open:** The **Open** for the request that is calling this algorithm.

- **Operation:** A code describing the operation being processed, per section 3.1.4.12.

- **OpParams:** Parameters associated with **Operation**, passed in from the calling request, per section 3.1.4.12.

The output is a Boolean. If the return value is TRUE, then no open files exist within the directory; if FALSE, then at least one open exists even after attempting to break oplocks.

Pseudocode for the algorithm is as follows:

- For each *OpenFile* in **File.Volume.OpenFileList**:

    - If *OpenFile*.**OpenList** contains any elements with **Link.ParentFile** equal to **File**:

        - For each *Stream* in *OpenFile*.**StreamList**:

            - If *Stream*.**Oplock** is not empty and *Stream*.**Oplock.State** contains either BATCH_OPLOCK or HANDLE_CACHING, the object store MUST check for an oplock break according to the algorithm in section 3.1.4.12, with input values as follows:

                - **Open** equal to this algorithm's **Open.**

                - **Operation** equal to this algorithm's **Operation.**

                - **OpParams** equal to this algorithm's **OpParams.**

            - EndIf

        - EndFor

    - EndIf

- EndFor

- // See if all oplock holders have gotten out of the way.

- For each *OpenFile* in **File.Volume.OpenFileList**:

    - If *OpenFile*.**OpenList** contains any elements with **Link.ParentFile** equal to **File**:

        - Return FALSE  // An open child still exists, deny the operation.

    - EndIf

- EndFor

- Return TRUE  // No opens remaining.

### 3.1.4.3  Algorithm for Determining If a Character Is a Wildcard

The following set of characters MUST be treated as wildcards by the object store:

" * < > ?

### 3.1.4.4  Algorithm for Determining if a FileName Is in an Expression

The inputs for this algorithm are:

- **FileName:** A Unicode string containing the file name string that is being matched. **Filename** may not contain any wildcard characters.

- **Expression:** A Unicode string containing the regular expression that's being matched with **FileName**.

- **IgnoreCase:** A Boolean value indicating whether the match is case insensitive (TRUE) or case sensitive (FALSE).

This algorithm returns TRUE if **FileName** matches **Expression**, and FALSE if it does not.

Pseudocode for the algorithm is as follows:

- Part 1 -- Handle Special Case Optimizations

- If **FileName** is empty and **Expression** is not, the routine returns FALSE.

- If **Expression** is empty and **FileName** is not, the routine returns FALSE.

- If both **Expression** and **FileName** are empty, the routine returns TRUE.

- If the **Expression** is the wildcard "*" or "*.*", the **FileName** matches the **Expression** and the routine returns TRUE.

- If the first character in the **Expression** is wildcard "*" and the rest of the expression does not contain any wildcard characters (as per 3.1.4.3), then the remaining expression is compared against the tail end of the **FileName**. If the comparison succeeds then the routine returns TRUE.

- Part 2 -- Match Expression with FileName

- The **FileName** is string compared with **Expression** using the following wildcard rules:

    - * (asterisk) Matches zero or more characters.

    - ? (question mark) Matches a single character.

    - DOS_DOT (" quotation mark) Matches either a period or zero characters beyond the name string.

    - DOS_QM (> greater than) Matches any single character or, upon encountering a period or end of name string, advances the expression to the end of the set of contiguous DOS_QMs.

    - DOS_STAR (< less than) Matches zero or more characters until encountering and matching the final . in the name.

### 3.1.4.5   BlockAlign -- Macro to Round a Value Up to the Next Nearest Multiple of Another Value

The inputs for this algorithm are:

- **Value:** The value being rounded up.

- **Boundary** - **Value** is to be rounded up to a multiple of this value. **Boundary** MUST be a power of 2.

This algorithm returns the bitwise AND of (**Value** + (**Boundary** - 1)) with the 2's complement of **Boundary**.

Pseudocode for the algorithm is as follows:

- BlockAlign(**Value, Boundary**) = (**Value** + (**Boundary** - 1)) & -(**Boundary**)

### 3.1.4.6   BlockAlignTruncate -- Macro to Round a Value Down to the Next Nearest Multiple of Another Value

The inputs for this algorithm are:

- **Value:** The value being rounded down.

- **Boundary** - **Value** is to be rounded down to a multiple of this value.**Boundary** MUST be a power of 2.

This algorithm returns the bitwise AND of **Value** with the 2's complement of **Boundary**.

Pseudocode for the algorithm is as follows:

- BlockAlignTruncate(**Value**, **Boundary**) = **Value** & -(**Boundary**)

### 3.1.4.7   ClustersFromBytes -- Macro to Determine How Many Clusters a Given Number of Bytes Occupies

The inputs for this algorithm are:

- **ThisVolume:** A **Volume**.

- **Bytes:** The number of bytes.

Pseudocode for the algorithm is as follows:

- ClustersFromBytes(**ThisVolume**, **Bytes**) = (**Bytes** + (**ThisVolume.ClusterSize** - 1)) / **ThisVolume.ClusterSize**.

- The value returned is the total number of clusters required to hold the specified number of bytes that start at a cluster boundary, including any remainder that does not fill a whole cluster.

### 3.1.4.8   ClustersFromBytesTruncate -- Macro to Determine How Many Whole Clusters a Given Number of Bytes Occupies

The inputs for this algorithm are:

- **ThisVolume:** A **Volume**.

▪ **Bytes:** The number of bytes.

Pseudocode for the algorithm is as follows:

▪ ClustersFromBytesTruncate(**ThisVolume**, **Bytes**) = **Bytes** / **ThisVolume.ClusterSize**.

▪ The value returned is the number of clusters that would be fully occupied by the specified number of bytes that start at a cluster boundary. Any remainder that does not fill a whole cluster is discarded.

### 3.1.4.9   SidLength -- Macro to Provide the Length of a SID

The inputs for this algorithm are:

▪ **SID:** A SID, as described in [MS-DTYP] section 2.4.2.

This algorithm returns the size, in bytes, of **SID**. This is equal to the number of bytes occupied by the **Revision**, **SubAuthorityCount**, and **IdentifierAuthorityCount** fields of a SID. Added to this is the size of a **SubAuthority** field of a SID times **SID.SubAuthorityCount**.

Pseudocode for the algorithm is as follows:

▪ *SidLength*(SID) = (8 + (4 * SID.SubAuthorityCount))

### 3.1.4.10   Algorithm for Determining If a Range Access Conflicts with Byte-Range Locks

The inputs for this algorithm are:

▪ **ByteOffset:** A 64-bit unsigned integer specifying the offset of the first byte of the range.

▪ **Length:** A 64-bit unsigned integer specifying the number of bytes in the range.

▪ **IsExclusive:** TRUE if the access to the range has exclusive intent, FALSE otherwise.

▪ **LockIntent:** TRUE if the access to the range has locking intent, FALSE if the intent is performing I/O (reads or writes).

▪ **Open:** The open to the file on which to check for range conflicts.

This algorithm outputs a Boolean value:

▪ TRUE if the range conflicts with byte-range locks.

▪ FALSE if the range does not conflict.

Pseudocode for the algorithm is as follows:

▪ If ((**ByteOffset** == 0) and (**Length** == 0)):

  ▪ The {0, 0} range doesn't conflict with any byte-range lock.

  ▪ Return FALSE.

▪ EndIf

▪ For each *ByteRangeLock* in **Open.Stream.ByteRangeLockList**:

- If ((*ByteRangeLock*.**LockOffset** == 0) and (*ByteRangeLock*.**LockLength** == 0)):

    - The byte-range lock is over the {0, 0} range so there is no overlap by definition.

- Else:

    - Initialize *LastByteOffset1* = **ByteOffset** + **Length** - 1.

    - Initialize *LastByteOffset2* = *ByteRangeLock*.**LockOffset** + *ByteRangeLock*.**LockLength** - 1.

    - If ((**ByteOffset** <= *LastByteOffset2*) and (*LastByteOffset1* >= *ByteRangeLock*.**LockOffset**)):

        - *ByteRangeLock* and the passed range overlap.

        - If (*ByteRangeLock*.**IsExclusive** == TRUE):

            - If (*ByteRangeLock*.**OwnerOpen** != **Open**):

                - Exclusive byte-range locks block all access to other **Opens**.

                - Return TRUE.

            - Else If ((**IsExclusive** == TRUE) and (**LockIntent** == TRUE)):

                - Overlapping exclusive byte-range locks are not allowed even by the same owner.

                - Return TRUE.

            - EndIf

        - Else If (**IsExclusive** == TRUE):

            - The *ByteRangeLock* is shared, shared byte-range locks will block all access with exclusive intent.

            - Return TRUE.

        - EndIf

    - EndIf

- EndIf

- EndFor

- Return FALSE.

### 3.1.4.11  Algorithm for Posting a USN Change for a File

The inputs for this algorithm are:

- **File:** The file this change occurs on.

- **Reason:** A 32-bit unsigned integer describing the change that occurred to the file, as specified in [MS-FSCC] section 2.3.40.

- **FileName:** The pathname, relative to **Volume.RootDirectory**, of the file this change occurs on.

The algorithm MUST return at this point without taking any actions under any of the following conditions:

- If the object store does not support USN change journals.

- If **File.Volume.IsUsnJournalActive** is FALSE.

- If **Reason** is zero.

Pseudocode for the algorithm is as follows:

- Set *FileNameLength* to the length, in bytes, of **FileName**.

- Set *RecordLength* to *BlockAlign(FieldOffset(*USN_RECORD.FileName*) + FileNameLength*, 8*)*.

- Set **File.Volume.LastUsn** to **File.Volume.LastUsn** + *RecordLength*.

- Set **File.Usn** to **File.Volume.LastUsn**.

### 3.1.4.12   Algorithm to Check for an Oplock Break

The inputs for this algorithm are:

- **Open:** The **Open** being used in the request calling this algorithm.

- **Operation:** A code describing the operation being processed.

- **OpParams:** Parameters associated with **Operation**, passed in from the calling request. For example, if **Operation** is OPEN, as specified in section 3.1.5.1, then **OpParams** will have members **DesiredAccess** and **CreateDisposition**.  Each of these is a parameter to the open request as specified in section 3.1.5.1.  This parameter MAY be empty, depending on **Operation**.

The algorithm uses the following local variables:

- Boolean values (initialized to FALSE): *BreakToTwo*, *BreakToNone*, *NeedToWait*

- *BreakCacheLevel* – MAY contain 0 or a combination of one or more of READ_CACHING, WRITE_CACHING, or HANDLE_CACHING, as specified in section 3.1.1.10.  Initialized to 0.

  - Note that there are only four legal nonzero combinations of flags for *BreakCacheLevel*:

    - (READ_CACHING|WRITE_CACHING|HANDLE_CACHING)

    - (READ_CACHING|WRITE_CACHING)

    - WRITE_CACHING

    - HANDLE_CACHING

Pseudocode for the algorithm is as follows:

If **Open.Stream.Oplock** is not empty and **Open.Stream.Oplock.State** is not NO_OPLOCK:

- Switch (**Operation**):

  - Case OPEN, as specified in section 3.1.5.1:

    - If **OpParams.DesiredAccess** contains no flags other than FILE_READ_ATTRIBUTES, FILE_WRITE_ATTRIBUTES, or SYNCHRONIZE, the algorithm returns at this point.

- EndIf

- If **OpParams.CreateDisposition** is FILE_SUPERSEDE, FILE_OVERWRITE, or FILE_OVERWRITE_IF:

    - Set *BreakToNone* to TRUE, set *BreakCacheLevel* to (READ_CACHING|WRITE_CACHING).

- Else

    - Set *BreakToTwo* to TRUE, set *BreakCacheLevel* to WRITE_CACHING.

- EndIf

- EndCase

- Case OPEN_BREAK_H, as specified in section 3.1.5.1:

    - Set *BreakCacheLevel* to HANDLE_CACHING.

- EndCase

- Case CLOSE, as specified in section 3.1.5.4:

    - If **Open.Stream.Oplock.IIOplocks** is not empty:

        - For each **Open** *ThisOpen* in **Open.Stream.Oplock.IIOplocks**:

            - If *ThisOpen* == **Open**:

                - Remove *ThisOpen* from **Open.Stream.Oplock.IIOplocks**.

                - Notify the **server** of an oplock break according to the algorithm in section 3.1.5.17.3, setting the algorithm's parameters as follows:

                    - **BreakingOplockOpen** equal to *ThisOpen*.

                    - **NewOplockLevel** equal to LEVEL_NONE.

                    - **AcknowledgeRequired** equal to FALSE.

                    - **ReturnStatus** equal to STATUS_SUCCESS.

                - (The operation does not end at this point; this call to 3.1.5.17.3 completes some earlier call to 3.1.5.17.2.)

            - EndIf

        - EndFor

        - Recompute **Open.Stream.Oplock.State** according to the algorithm in section 3.1.4.13, passing **Open.Stream.Oplock** as the **ThisOplock** parameter.

    - EndIf

    - If **Open.Stream.Oplock.ROplocks** is not empty:

        - For each **Open** *ThisOpen* in **Open.Stream.Oplock.ROplocks**:

            - If *ThisOpen* == **Open**:

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- Remove *ThisOpen* from **Open.Stream.Oplock.ROplocks**.

- Notify the server of an oplock break according to the algorithm in section 3.1.5.17.3, setting the algorithm's parameters as follows:

  - **BreakingOplockOpen** equal to *ThisOpen*.

  - **NewOplockLevel** equal to LEVEL_NONE.

  - **AcknowledgeRequired** equal to FALSE.

  - **ReturnStatus** equal to STATUS_OPLOCK_HANDLE_CLOSED.

- (The operation does not end at this point; this call to 3.1.5.17.3 completes some earlier call to 3.1.5.17.2.)

  - EndIf

  - EndFor

  - Recompute **Open.Stream.Oplock.State** according to the algorithm in section 3.1.4.13, passing **Open.Stream.Oplock** as the **ThisOplock** parameter.

- EndIf

- If **Open.Stream.Oplock.RHOplocks** is not empty:

  - For each **Open** *ThisOpen* in **Open.Stream.Oplock.RHOplocks**:

    - If *ThisOpen* == **Open**:

      - Remove *ThisOpen* from **Open.Stream.Oplock.RHOplocks**.

      - Notify the server of an oplock break according to the algorithm in section 3.1.5.17.3, setting the algorithm's parameters as follows:

        - **BreakingOplockOpen** equal to *ThisOpen*.

        - **NewOplockLevel** equal to LEVEL_NONE.

        - **AcknowledgeRequired** equal to FALSE.

        - **ReturnStatus** equal to STATUS_OPLOCK_HANDLE_CLOSED.

      - (The operation does not end at this point; this call to 3.1.5.17.3 completes some earlier call to 3.1.5.17.2.)

    - EndIf

  - EndFor

  - Recompute **Open.Stream.Oplock.State** according to the algorithm in section 3.1.4.13, passing **Open.Stream.Oplock** as the **ThisOplock** parameter.

- EndIf

- If **Open.Stream.Oplock.RHBreakQueue** is not empty:

  - For each **RHOpContext** *ThisContex* in **Open.Stream.Oplock.RHBreakQueue**:

- If *ThisContext*.**Open** == **Open**:

  - Remove *ThisContex* from **Open.Stream.Oplock.RHBreakQueue**.

- EndIf

- EndFor

- Recompute **Open.Stream.Oplock.State** according to the algorithm in section 3.1.4.13, passing **Open.Stream.Oplock** as the **ThisOplock** parameter.

- For each **Open** *WaitingOpen* on **Open.Stream.Oplock.WaitList**:

  - If **Open.Stream.Oplock.RHBreakQueue** is empty:

    - Indicate that the operation associated with *WaitingOpen* may continue according to the algorithm in section 3.1.4.12.1, setting **OpenToRelease** equal to *WaitingOpen*.

    - Remove *WaitingOpen* from **Open.Stream.Oplock.WaitList**.

  - Else

    - If the value on every **RHOpContext.Open.OplockKey** on **Open.Stream.Oplock.RHBreakQueue** is equal to *WaitingOpen* .**OplockKey**:

      - Indicate that the operation associated with *WaitingOpen* may continue according to the algorithm in section 3.1.4.12.1, setting **OpenToRelease** equal to *WaitingOpen*.

      - Remove *WaitingOpen* from **Open.Stream.Oplock.WaitList**.

    - EndIf

  - EndIf

- EndFor

- EndIf

- If **Open** equals **Open.Oplock.ExclusiveOpen**

  - If **Open.Stream.Oplock.State** contains none of BREAK_TO_TWO, BREAK_TO_NONE, BREAK_TO_TWO_TO_NONE, BREAK_TO_READ_CACHING, BREAK_TO_WRITE_CACHING, BREAK_TO_HANDLE_CACHING, or BREAK_TO_NO_CACHING:

    - Notify the server of an oplock break according to the algorithm in section 3.1.5.17.3, setting the algorithm's parameters as follows:

      - **BreakingOplockOpen** equal to **Open.Stream.Oplock.ExclusiveOpen**.

      - **NewOplockLevel** equal to LEVEL_NONE.

      - **AcknowledgeRequired** equal to FALSE.

      - **ReturnStatus** equal to:

        - STATUS_OPLOCK_HANDLE_CLOSED if **Open.Stream.Oplock.State** contains any of READ_CACHING, WRITE_CACHING, or HANDLE_CACHING.

- STATUS_SUCCESS otherwise.

- (The operation does not end at this point; this call to 3.1.5.17.3 completes some earlier call to 3.1.5.17.1.)

- EndIf

- Set **Open.Stream.Oplock.ExclusiveOpen** to NULL.

- Set **Open.Stream.Oplock.State** to NO_OPLOCK.

- For each **Open** *WaitingOpen* on **Open.Stream.Oplock.WaitList**:

  - Indicate that the operation associated with *WaitingOpen* may continue according to the algorithm in section 3.1.4.12.1, setting **OpenToRelease** equal to *WaitingOpen*.

    - Remove *WaitingOpen* from **Open.Stream.Oplock.WaitList**.

  - EndFor

- EndIf

- EndCase

- Case READ, as specified in section 3.1.5.2:

  - Set *BreakToTwo* to TRUE

  - Set *BreakCacheLevel* to WRITE_CACHING.

- EndCase

- Case FLUSH_DATA, as specified in section 3.1.5.6:

  - Set *BreakToTwo* to TRUE

  - Set *BreakCacheLevel* to WRITE_CACHING.

- EndCase

- Case LOCK_CONTROL, as specified in section 3.1.5.7:

- Case WRITE, as specified in section 3.1.5.3:

  - Set *BreakToNone* to TRUE

  - Set *BreakCacheLevel* to (READ_CACHING|WRITE_CACHING).

- EndCase

- Case SET_INFORMATION, as specified in section 3.1.5.14:

  - Switch (**OpParams.FileInformationClass**):

  - Case FileEndOfFileInformation:

  - Case FileAllocationInformation:

    - Set *BreakToNone* to TRUE

- Set *BreakCacheLevel* to (READ_CACHING|WRITE_CACHING).

- EndCase

- Case FileRenameInformation:

- Case FileLinkInformation:

- Case FileShortNameInformation:

  - Set *BreakCacheLevel* to HANDLE_CACHING.

  - If **Open.Stream.Oplock.State** contains BATCH_OPLOCK, set *BreakToNone* to TRUE.

- EndCase

- Case FileDispositionInformation:

  - If **OpParams.DeleteFile** is TRUE,

  - Set *BreakCacheLevel* to HANDLE_CACHING.

- EndCase

- EndSwitch // FileInfoClass

- Case FS_CONTROL, as specified in section [3.1.5.9](#):

  - If **OpParams.ControlCode** is FSCTL_SET_ZERO_DATA:

    - Set *BreakToNone* to TRUE.

    - Set *BreakCacheLevel* to (READ_CACHING|WRITE_CACHING).

  - EndIf

- EndCase

- EndSwitch // **Operation**

- If *BreakToTwo* is TRUE:

  - If (**Open.Stream.Oplock.State** != LEVEL_TWO_OPLOCK) and

    ((**Open.Stream.Oplock.ExclusiveOpen** is empty) or

    (**Open.Stream.Oplock.ExclusiveOpen.OplockKey** != **Open.OplockKey**)):

  - If (**Open.Stream.Oplock.State** contains EXCLUSIVE) and

    (**Open.Stream.Oplock.State** contains none of READ_CACHING, WRITE_CACHING, or HANDLE_CACHING):

    - If **Open.Stream.Oplock.State** contains none of BREAK_TO_TWO, BREAK_TO_NONE, BREAK_TO_TWO_TO_NONE, BREAK_TO_READ_CACHING, BREAK_TO_WRITE_CACHING, BREAK_TO_HANDLE_CACHING, or BREAK_TO_NO_CACHING:

      - // **Open.Stream.Oplock.State** MUST contain either LEVEL_ONE_OPLOCK or BATCH_OPLOCK.

- Set BREAK_TO_TWO in **Open.Stream.Oplock.State**.

- Notify the server of an oplock break according to the algorithm in section 3.1.5.17.3, setting the algorithm's parameters as follows:

  - **BreakingOplockOpen** equal to **Open.Stream.Oplock.ExclusiveOpen**.

  - **NewOplockLevel** equal to LEVEL_TWO.

  - **AcknowledgeRequired** equal to TRUE.

  - **ReturnStatus** equal to STATUS_SUCCESS.

- (The operation does not end at this point; this call to 3.1.5.17.3 completes some earlier call to 3.1.5.17.1.)

- EndIf

- The operation that called this algorithm MUST be made cancelable by inserting it into **CancelableOperations.CancelableOperationList**.

- The operation that called this algorithm waits until the oplock break is acknowledged, as specified in section 3.1.5.18, or the operation is canceled.

- EndIf

- EndIf

- Else If *BreakToNone* is TRUE:

  - If (**Open.Stream.Oplock.State** == LEVEL_TWO_OPLOCK) or

    (**Open.Stream.Oplock.ExclusiveOpen** is empty) or

    (**Open.Stream.Oplock.ExclusiveOpen.OplockKey** != **Open.OplockKey**):

    - If (**Open.Stream.Oplock.State** != NO_OPLOCK) and

      (**Open.Stream.Oplock.State** contains neither WRITE_CACHING nor HANDLE_CACHING):

      - If **Open.Stream.Oplock.State** contains none of LEVEL_TWO_OPLOCK, BREAK_TO_TWO, BREAK_TO_NONE, BREAK_TO_TWO_TO_NONE, BREAK_TO_READ_CACHING, BREAK_TO_WRITE_CACHING, BREAK_TO_HANDLE_CACHING, or BREAK_TO_NO_CACHING:

        - // There could be a READ_CACHING-only oplock here. Those are broken later on.

        - If **Open.Stream.Oplock.State** contains READ_CACHING, go to the *LeaveBreakToNone* label.

        - Set BREAK_TO_NONE in **Open.Stream.Oplock.State**.

        - Notify the server of an oplock break according to the algorithm in section 3.1.5.17.3, setting the algorithm's parameters as follows:

          - **BreakingOplockOpen** equal to **Open.Stream.Oplock.ExclusiveOpen**.

          - **NewOplockLevel** equal to LEVEL_NONE.

- **AcknowledgeRequired** equal to TRUE.

- **ReturnStatus** equal to STATUS_SUCCESS.

- (The operation does not end at this point; this call to 3.1.5.17.3 completes some earlier call to 3.1.5.17.1.)

- Else If **Open.Stream.Oplock.State** equals LEVEL_TWO_OPLOCK or (LEVEL_TWO_OPLOCK|READ_CACHING):

  - For each **Open** *ThisOpen* in **Open.Stream.Oplock.IIOplocks**:

    - Remove *ThisOpen* from **Open.Stream.Oplock.IIOplocks**.

    - Notify the server of an oplock break according to the algorithm in section 3.1.5.17.3, setting the algorithm's parameters as follows:

      - **BreakingOplockOpen** equal to *ThisOpen*.

      - **NewOplockLevel** equal to LEVEL_NONE.

      - **AcknowledgeRequired** equal to FALSE.

      - **ReturnStatus** equal to STATUS_SUCCESS.

    - (The operation does not end at this point; this call to 3.1.5.17.3 completes some earlier call to 3.1.5.17.2.)

  - EndFor

  - If **Open.Stream.Oplock.State** equals (LEVEL_TWO_OPLOCK|READ_CACHING):

    - Set **Open.Stream.Oplock.State** equal to READ_CACHING.

  - Else

    - Set **Open.Stream.Oplock.State** equal to NO_OPLOCK.

  - EndIf

  - Go to the *LeaveBreakToNone* label.

- Else If **Open.Stream.Oplock.State** contains BREAK_TO_TWO:

  - Clear BREAK_TO_TWO from **Open.Stream.Oplock.State**.

  - Set BREAK_TO_TWO_TO_NONE in **Open.Stream.Oplock.State**.

- EndIf

- If **Open.Stream.Oplock.ExclusiveOpen** is not empty, and **Open.Stream.Oplock.ExclusiveOpen.OplockKey** equals **Open.OplockKey**, go to the *LeaveBreakToNone* label.

- The operation that called this algorithm MUST be made cancelable by inserting it into **CancelableOperations.CancelableOperationList**.

- The operation that called this algorithm waits until the oplock break is acknowledged, as specified in section 3.1.5.18, or the operation is canceled.

- ▪ EndIf

  - ▪ EndIf

- ▪ EndIf

  *LeaveBreakToNone* (goto destination label):

- ▪ If *BreakCacheLevel* is not 0:

  - ▪ If **Open.Stream.Oplock.State** contains any flags that are in *BreakCacheLevel*:

    - ▪ If **Open.Stream.Oplock.ExclusiveOpen** is not empty, and **Open.Stream.Oplock.ExclusiveOpen.OplockKey** equals **Open.OplockKey**, the algorithm returns at this point.

    - ▪ Switch (**Open.Stream.Oplock.State**):

      - ▪ Case (READ_CACHING|HANDLE_CACHING|MIXED_R_AND_RH):

      - ▪ Case READ_CACHING:

      - ▪ Case (LEVEL_TWO_OPLOCK|READ_CACHING):

        - ▪ If *BreakCacheLevel* contains READ_CACHING:

          - ▪ For each **Open** *ThisOpen* in **Open.Stream.Oplock.ROplocks**:

            - ▪ If *ThisOpen*.**OplockKey** does not equal **Open.OplockKey**:

              - ▪ Remove *ThisOpen* from **Open.Stream.Oplock.ROplocks**.

              - ▪ Notify the server of an oplock break according to the algorithm in section 3.1.5.17.3, setting the algorithm's parameters as follows:

                - ▪ **BreakingOplockOpen** equal to *ThisOpen*.

                - ▪ **NewOplockLevel** equal to LEVEL_NONE.

                - ▪ **AcknowledgeRequired** equal to FALSE.

                - ▪ **ReturnStatus** equal to STATUS_SUCCESS.

              - ▪ (The operation does not end at this point; this call to 3.1.5.17.3 completes some earlier call to 3.1.5.17.2.)

            - ▪ EndIf

          - ▪ EndFor

        - ▪ EndIf

        - ▪ If **Open.Stream.Oplock.State** equals (READ_CACHING|HANDLE_CACHING|MIXED_R_AND_RH):

          - ▪ // Do nothing; FALL THROUGH to next Case statement.

        - ▪ Else

- Recompute **Open.Stream.Oplock.State** according to the algorithm in section [3.1.4.13](#), passing **Open.Stream.Oplock** as the **ThisOplock** parameter.

- EndCase

- EndIf

- Case (READ_CACHING|HANDLE_CACHING):

  - If *BreakCacheLevel* equals HANDLE_CACHING:

    - For each **Open** *ThisOpen* in **Open.Stream.Oplock.RHOplocks**:

      - If *ThisOpen*.**OplockKey** does not equal **Open.OplockKey**:

        - Remove *ThisOpen* from **Open.Stream.Oplock.RHOplocks**.

        - Notify the server of an oplock break according to the algorithm in section [3.1.5.17.3](#), setting the algorithm's parameters as follows:

          - **BreakingOplockOpen** equal to *ThisOpen*.

          - **NewOplockLevel** equal to READ_CACHING.

          - **AcknowledgeRequired** equal to TRUE.

          - **ReturnStatus** equal to STATUS_SUCCESS.

        - (The operation does not end at this point; this call to [3.1.5.17.3](#) completes some earlier call to [3.1.5.17.2](#).)

        - Initialize a new **RHOpContext** object, setting its fields as follows:

          - **RHOpContext.Open** set to *ThisOpen*.

          - **RHOpContext.BreakingToRead** to TRUE.

        - Add the new **RHOpContext** object to **Open.Stream.Oplock.RHBreakQueue**.

        - Set *NeedToWait* to TRUE.

      - EndIf

    - EndFor

  - Else If *BreakCacheLevel* contains both READ_CACHING and WRITE_CACHING:

    - For each **RHOpContext** *ThisContex* in **Open.Stream.Oplock.RHBreakQueue**:

      - If *ThisContext*.**Open.OplockKey** does not equal **Open.OplockKey**:

        - Set *ThisContex*.**BreakingToRead** to FALSE.

        - If *BreakCacheLevel* contains HANDLE_CACHING:

          - Set *NeedToWait* to TRUE.

        - EndIf

- EndIf

- EndFor

- For each **Open** *ThisOpen* in **Open.Stream.Oplock.RHOplocks**:

  - If *ThisOpen*.**OplockKey** does not equal **Open.OplockKey**:

    - Remove *ThisOpen* from **Open.Stream.Oplock.RHOplocks**.

    - Notify the server of an oplock break according to the algorithm in section 3.1.5.17.3, setting the algorithm's parameters as follows:

      - **BreakingOplockOpen** equal to *ThisOpen*.

      - **NewOplockLevel** equal to LEVEL_NONE.

      - **AcknowledgeRequired** equal to TRUE.

      - **ReturnStatus** equal to STATUS_SUCCESS.

    - (The operation does not end at this point; this call to 3.1.5.17.3 completes some earlier call to 3.1.5.17.2.)

    - Initialize a new **RHOpContext** object, setting its fields as follows:

      - **RHOpContext.Open** set to *ThisOpen*.

      - **RHOpContext.BreakingToRead** to FALSE.

    - Add the new **RHOpContext** object to **Open.Stream.Oplock.RHBreakQueue**.

    - If *BreakCacheLevel* contains HANDLE_CACHING:

      - Set *NeedToWait* to TRUE.

    - EndIf

  - EndIf

- EndFor

- EndIf

- // If the oplock is explicitly losing HANDLE_CACHING, **RHBreakQueue** is not empty,

- // and the algorithm has not yet decided to wait, this operation may have to wait if

- // there is an oplock on **RHBreakQueue** with a non-matching key. This is done

- // because even if this operation didn't cause a break of a currently-granted Read-

- // Handle caching oplock, it may have done so had a currently-breaking oplock still

- // been granted.

- If (*NeedToWait* is FALSE) and

    (**Open.Stream.Oplock.RHBreakQueue** is empty) and

(*BreakCacheLevel* contains HANDLE_CACHING):

- For each **RHOpContext** *ThisContex* in **Open.Stream.Oplock.RHBreakQueue**:

  - If *ThisContext*.**Open.OplockKey** does not equal **Open.OplockKey**:

    - Set *NeedToWait* to TRUE.

    - Break out of the For loop.

  - EndIf

- EndFor

- EndIf

- Recompute **Open.Stream.Oplock.State** according to the algorithm in section [3.1.4.13](#), passing **Open.Stream.Oplock** as the **ThisOplock** parameter.

- EndCase

- Case (READ_CACHING|HANDLE_CACHING|BREAK_TO_READ_CACHING):

  - If *BreakCacheLevel* contains READ_CACHING:

    - For each **RHOpContext** *ThisContex* in **Open.Stream.Oplock.RHBreakQueue**:

      - If *ThisContext*.**Open.OplockKey** does not equal **Open.OplockKey**:

        - Set *ThisContex*.**BreakingToRead** to FALSE.

      - EndIf

      - Recompute **Open.Stream.Oplock.State** according to the algorithm in section [3.1.4.13](#), passing **Open.Stream.Oplock** as the **ThisOplock** parameter.

    - EndFor

  - EndIf

  - If *BreakCacheLevel* contains HANDLE_CACHING:

    - For each **RHOpContext** *ThisContex* in **Open.Stream.Oplock.RHBreakQueue**:

      - If *ThisContext*.**Open.OplockKey** does not equal **Open.OplockKey**:

        - Set *NeedToWait* to TRUE.

        - Break out of the For loop.

      - EndIf

    - EndFor

  - EndIf

- EndCase

- Case (READ_CACHING|HANDLE_CACHING|BREAK_TO_NO_CACHING):

- If *BreakCacheLevel* contains HANDLE_CACHING:

    - For each **RHOpContext** *ThisContex* in **Open.Stream.Oplock.RHBreakQueue**:

        - If *ThisContext*.**Open.OplockKey** does not equal **Open.OplockKey**:

            - Set *NeedToWait* to TRUE.

            - Break out of the For loop.

        - EndIf

    - EndFor

- EndIf

- EndCase

- Case (READ_CACHING|WRITE_CACHING|EXCLUSIVE):

    - If *BreakCacheLevel* contains both READ_CACHING and WRITE_CACHING:

        - Notify the server of an oplock break according to the algorithm in section 3.1.5.17.3, setting the algorithm's parameters as follows:

            - **BreakingOplockOpen** equal to **Open.Stream.Oplock.ExclusiveOpen**.

            - **NewOplockLevel** equal to LEVEL_NONE.

            - **AcknowledgeRequired** equal to TRUE.

            - **ReturnStatus** equal to STATUS_SUCCESS.

        - (The operation does not end at this point; this call to 3.1.5.17.3 completes some earlier call to 3.1.5.17.1.)

        - Set **Open.Stream.Oplock.State** to (READ_CACHING|WRITE_CACHING|EXCLUSIVE|BREAK_TO_NO_CACHING).

        - Set *NeedToWait* to TRUE.

    - Else If *BreakCacheLevel* contains WRITE_CACHING:

        - Notify the server of an oplock break according to the algorithm in section 3.1.5.17.3, setting the algorithm's parameters as follows:

            - **BreakingOplockOpen** equal to **Open.Stream.Oplock.ExclusiveOpen**.

            - **NewOplockLevel** equal to READ_CACHING.

            - **AcknowledgeRequired** equal to TRUE.

            - **ReturnStatus** equal to STATUS_SUCCESS.

        - (The operation does not end at this point; this call to 3.1.5.17.3 completes some earlier call to 3.1.5.17.1.)

        - Set **Open.Stream.Oplock.State** to (READ_CACHING|WRITE_CACHING| EXCLUSIVE|BREAK_TO_READ_CACHING).

- Set *NeedToWait* to TRUE.

- EndIf

- EndCase

- Case (READ_CACHING|WRITE_CACHING|HANDLE_CACHING|EXCLUSIVE):

  - If *BreakCacheLevel* equals WRITE_CACHING:

    - Notify the server of an oplock break according to the algorithm in section 3.1.5.17.3, setting the algorithm's parameters as follows:

      - **BreakingOplockOpen** equal to **Open.Stream.Oplock.ExclusiveOpen**.

      - **NewOplockLevel** equal to (READ_CACHING|HANDLE_CACHING).

      - **AcknowledgeRequired** equal to TRUE.

      - **ReturnStatus** equal to STATUS_SUCCESS.

    - (The operation does not end at this point; this call to 3.1.5.17.3 completes some earlier call to 3.1.5.17.1.)

    - Set **Open.Stream.Oplock.State** to (READ_CACHING|WRITE_CACHING|HANDLE_CACHING|EXCLUSIVE|BREAK_TO_READ_CACHING|BREAK_TO_HANDLE_CACHING).

    - Set *NeedToWait* to TRUE.

  - Else If *BreakCacheLevel* equals HANDLE_CACHING:

    - Notify the server of an oplock break according to the algorithm in section 3.1.5.17.3, setting the algorithm's parameters as follows:

      - **BreakingOplockOpen** equal to **Open.Stream.Oplock.ExclusiveOpen**.

      - **NewOplockLevel** equal to (READ_CACHING|WRITE_CACHING).

      - **AcknowledgeRequired** equal to TRUE.

      - **ReturnStatus** equal to STATUS_SUCCESS.

    - (The operation does not end at this point; this call to 3.1.5.17.3 completes some earlier call to 3.1.5.17.1.)

    - Set **Open.Stream.Oplock.State** to (READ_CACHING|WRITE_CACHING|HANDLE_CACHING|EXCLUSIVE|BREAK_TO_READ_CACHING|BREAK_TO_WRITE_CACHING).

    - Set *NeedToWait* to TRUE.

  - Else If *BreakCacheLevel* contains both READ_CACHING and WRITE_CACHING:

    - Notify the server of an oplock break according to the algorithm in section 3.1.5.17.3, setting the algorithm's parameters as follows:

      - **BreakingOplockOpen** equal to **Open.Stream.Oplock.ExclusiveOpen**.

- **NewOplockLevel** equal to LEVEL_NONE.

- **AcknowledgeRequired** equal to TRUE.

- **ReturnStatus** equal to STATUS_SUCCESS.

- (The operation does not end at this point; this call to 3.1.5.17.3 completes some earlier call to 3.1.5.17.1.)

- Set **Open.Stream.Oplock.State** to (READ_CACHING|WRITE_CACHING|HANDLE_CACHING|EXCLUSIVE|BREAK_TO_NO_CACHING).

- Set *NeedToWait* to TRUE.

- EndIf

- EndCase

- Case (READ_CACHING|WRITE_CACHING|EXCLUSIVE|BREAK_TO_READ_CACHING):

  - If *BreakCacheLevel* contains READ_CACHING:

    - Set **Open.Stream.Oplock.State** to (READ_CACHING|WRITE_CACHING|EXCLUSIVE|BREAK_TO_NO_CACHING).

  - EndIf

  - If *BreakCacheLevel* contains either READ_CACHING or WRITE_CACHING:

    - Set *NeedToWait* to TRUE.

  - EndIf

- EndCase

- Case (READ_CACHING|WRITE_CACHING|EXCLUSIVE|BREAK_TO_NO_CACHING):

  - If *BreakCacheLevel* contains either READ_CACHING or WRITE_CACHING:

    - Set *NeedToWait* to TRUE.

  - EndIf

- EndCase

- Case (READ_CACHING|WRITE_CACHING|HANDLE_CACHING|EXCLUSIVE|BREAK_TO_READ_CACHING|BREAK_TO_WRITE_CACHING):

  - If *BreakCacheLevel* == WRITE_CACHING:

    - Set **Open.Stream.Oplock.State** to (READ_CACHING|WRITE_CACHING|HANDLE_CACHING|EXCLUSIVE|BREAK_TO_READ_CACHING).

  - Else If *BreakCacheLevel* contains both READ_CACHING and WRITE_CACHING:

- Set **Open.Stream.Oplock.State** to (READ_CACHING|WRITE_CACHING|HANDLE_CACHING|EXCLUSIVE|BREAK_TO_N O_CACHING).

- EndIf

- Set *NeedToWait* to TRUE.

- EndCase

- Case (READ_CACHING|WRITE_CACHING|HANDLE_CACHING|EXCLUSIVE|BREAK_TO_READ_C ACHING|BREAK_TO_HANDLE_CACHING):

  - If *BreakCacheLevel* == HANDLE_CACHING:

    - Set **Open.Stream.Oplock.State** to (READ_CACHING|WRITE_CACHING|HANDLE_CACHING|EXCLUSIVE|BREAK_TO_RE AD_CACHING).

  - Else If *BreakCacheLevel* contains READ_CACHING:

    - Set **Open.Stream.Oplock.State** to (READ_CACHING|WRITE_CACHING|HANDLE_CACHING|EXCLUSIVE|BREAK_TO_N O_CACHING).

  - EndIf

  - Set *NeedToWait* to TRUE.

- EndCase

- Case (READ_CACHING|WRITE_CACHING|HANDLE_CACHING|EXCLUSIVE|BREAK_TO_READ_C ACHING):

  - If *BreakCacheLevel* contains READ_CACHING, set **Open.Stream.Oplock.State** to (READ_CACHING|WRITE_CACHING|HANDLE_CACHING|EXCLUSIVE|BREAK_TO_NO_ CACHING).

  - Set *NeedToWait* to TRUE.

- EndCase

- Case (READ_CACHING|WRITE_CACHING|HANDLE_CACHING|EXCLUSIVE|BREAK_TO_NO_CAC HING):

  - Set *NeedToWait* to TRUE.

- EndCase

- EndSwitch

- If *NeedToWait* is TRUE:

  - The operation that called this algorithm MUST be made cancelable by inserting it into **CancelableOperations.CancelableOperationList**.

- The operation that called this algorithm waits until the oplock break is acknowledged, as specified in section 3.1.5.18, or the operation is canceled.

- EndIf

- EndIf

- EndIf

EndIf

### 3.1.4.12.1 Algorithm for Request Processing After an Oplock Breaks

The inputs for this algorithm are:

- **OpenToRelease:** The **Open** used in the request that caused the oplock to break

Pseudocode for the algorithm is as follows:

- The request corresponding to **OpenToRelease** MUST resume from the point where it broke the oplock (that is, called section 3.1.4.12).

### 3.1.4.13 Algorithm to Recompute the State of a Shared Oplock

The inputs for this algorithm are:

- **ThisOplock:** The **Oplock** on whose state is being recomputed.

Pseudocode for the algorithm is as follows:

- If **ThisOplock.IIOplocks**, **ThisOplock.ROplocks**, **ThisOplock.RHOplocks**, and **ThisOplock.RHBreakQueue** are all empty:

  - Set **ThisOplock.State** to NO_OPLOCK.

- Else If **ThisOplock.ROplocks** is not empty and either **ThisOplock.RHOplocks** or **ThisOplock.RHBreakQueue** are not empty:

  - Set **ThisOplock.State** to (READ_CACHING|HANDLE_CACHING|MIXED_R_AND_RH).

- Else If **ThisOplock.ROplocks** is empty and **ThisOplock.RHOplocks** is not empty:

  - Set **ThisOplock.State** to (READ_CACHING|HANDLE_CACHING).

- Else If **ThisOplock.ROplocks** is not empty and **ThisOplock.IIOplocks** is not empty:

  - Set **ThisOplock.State** to (READ_CACHING|LEVEL_TWO_OPLOCK).

- Else If **ThisOplock.ROplocks** is not empty and **ThisOplock.IIOplocks** is empty:

  - Set **ThisOplock.State** to READ_CACHING.

- Else If **ThisOplock.ROplocks** is empty and **ThisOplock.IIOplocks** is not empty:

  - Set **ThisOplock.State** to LEVEL_TWO_OPLOCK.

- Else

  - // **ThisOplock.RHBreakQueue** MUST be non-empty by this point.

- If **RHOpContext.BreakingToRead** is TRUE for every **RHOpContext** on **ThisOplock.RHBreakQueue**:

  - Set **ThisOplock.State** to (READ_CACHING|HANDLE_CACHING|BREAK_TO_READ_CACHING).

- Else If **RHOpContext.BreakingToRead** is FALSE for every **RHOpContext** on **ThisOplock.RHBreakQueue**:

  - Set **ThisOplock.State** to (READ_CACHING|HANDLE_CACHING|BREAK_TO_NO_CACHING).

- Else:

  - Set **ThisOplock.State** to (READ_CACHING|HANDLE_CACHING).

- EndIf

- EndIf

### 3.1.4.14   AccessCheck -- Algorithm to Perform a General Access Check

The inputs for this algorithm are:

- **SecurityContext:** The **SecurityContext** of the user requesting access.

- **SecurityDescriptor:** The security descriptor of the object to which access is requested, in the format specified in [MS-DTYP] section 2.4.6.

- **DesiredAccess:** An ACCESS_MASK indicating type of access requested, as specified in [MS-DTYP] section 2.4.3.

This algorithm returns a Boolean value:

- TRUE if the user has the necessary access to the object.

- FALSE otherwise.

Pseudocode for the algorithm is as follows:

- The object store MUST build a new *Token* object, in the format specified in [MS-DTYP] section 2.5.2, with fields initialized as follows:

  - **SIDs** set to **SecurityContext.SIDs**.

  - **OwnerIndex** set to **SecurityContext.OwnerIndex**.

  - **PrimaryGroup** set to **SecurityContext.PrimaryGroup**.

  - **DefaultDACL** set to **SecurityContext.DefaultDACL**.

  - **SystemACLAccess** set to TRUE if **SecurityContext.PrivilegeSet** contains "SeSecurityPrivilege", FALSE otherwise.

  - **TakeOwnership** set to TRUE if **SecurityContext.PrivilegeSet** contains "SeTakeOwnershipPrivilege", FALSE otherwise.

- The object store MUST use the access check algorithm described in [MS-DTYP] section 2.5.3.2, with input values as follows:

- **SecurityDescriptor** set to the **SecurityDescriptor** above.

- **Token** set to *Token*.

- **Access Request mask** set to **DesiredAccess**.

- **Object Tree** set to NULL.

- **PrincipalSelfSubst** set to NULL.

- If the access check returns success, return TRUE; otherwise return FALSE.

## 3.1.5 Higher-Layer Triggered Events

This section describes operations the object store performs in response to events triggered by higher-layer applications. The higher-layer application for this document is generally a server application that is processing requests for a local or remote client.

In performing these operations, the object store MAY make persistent changes to objects described in the abstract data model, section 3.1.1. If any operation fails, the object store SHOULD undo any persistent changes that were made prior to the failure, unless specifically noted otherwise in the operation.

Each operation in this section has an implementation-specific identifier (**IORequest**) that uniquely identifies in-progress I/O operation. The **IORequest** parameter is used to support operation cancelation, as specified in section 3.1.5.19.

When an operation completes or is canceled the object store MUST remove the associated **IORequest** operation from **CancelableOperations.CancelableOperationList.**

### 3.1.5.1 Server Requests an Open of a File

The server provides:

- **RootOpen:** An **Open** to the root of the share.

- **PathName:** A Unicode path relative to **RootOpen** for the file to be opened in the format specified in [MS-FSCC] section 2.1.5.

- **SecurityContext:** The **SecurityContext** of the user performing the open.

- **DesiredAccess:** A bitmask indicating requested access for the open, as specified in [MS-SMB2] section 2.2.13.1.

- **ShareAccess:** A bitmask indicating sharing access for the open, as specified in [MS-SMB2] section 2.2.13.

- **CreateOptions:** A bitmask of options for the open, as specified in [MS-SMB2] section 2.2.13.

- **CreateDisposition:** The requested disposition for the open, as specified in [MS-SMB2] section 2.2.13.

- **DesiredFileAttributes:** A bitmask of requested file attributes for the open, as specified in [MS-SMB2] section 2.2.13.

- **IsCaseInsensitive:** A Boolean value. TRUE indicates that string comparisons performed in the context of this Open should be case-insensitive, otherwise they should be case-sensitive.

- **OplockKey:** A GUID value. This value MAY be empty.

- **UserCertificate:** An ENCRYPTION_CERTIFICATE structure as specified in [MS-EFSR] section 2.2.8, used when opening an encrypted stream. This value MAY be empty.

On completion, the object store MUST return:

- **Status:** An NTSTATUS code that specifies the result.

On success it MUST also return:

- **CreateAction:** A code defining the action taken by the open operation, as specified in [MS-SMB2] section 2.2.14 for the **CreateAction** field.

- **Open:** The newly created **Open**.

On STATUS_REPARSE or STATUS_STOPPED_ON_SYMLINK it MUST also return:

- **ReparseData:** The reparse point data associated with an existing file, in the format described in [MS-FSCC] section 2.1.2. The application MAY retry the open operation with a different **PathName** parameter constructed using **ReparseData**.

Pseudocode for the operation is as follows:

- Phase 1 -- Parameter Validation:

- The operation MUST be failed with STATUS_INVALID_PARAMETER under any of the following conditions:

  - If **RootOpen.File.FileType** is DataFile.

  - If **DesiredAccess** is not a valid value as specified in [MS-SMB2] section 2.2.13.1.

  - If **ShareAccess**, **CreateOptions**, **CreateDisposition**, or **FileAttributes** are not valid values for a file object as specified in [MS-SMB2] section 2.2.13.

  - If **CreateOptions.FILE_DIRECTORY_FILE** && **CreateOptions.FILE_NON_DIRECTORY_FILE**.

  - If (**CreateOptions.FILE_SYNCHRONOUS_IO_ALERT** || **Create.FILE_SYNCHRONOUS_IO_NONALERT**) && !**DesiredAccess.SYNCHRONIZE**.

  - If **CreateOptions.FILE_DELETE_ON_CLOSE** && !**DesiredAccess.DELETE**.

  - If **CreateOptions.FILE_SYNCHRONOUS_IO_ALERT** && **Create.FILE_SYNCHRONOUS_IO_NONALERT**.

  - If **CreateOptions.FILE_DIRECTORY_FILE** && (**CreateDisposition == SUPERSEDE** || **CreateDisposition == OVERWRITE** || **CreateDisposition == OVERWRITE_IF**).

  - If **CreateOptions.COMPLETE_IF_OPLOCKED** && **CreateOptions.FILE_RESERVE_OPFILTER**.

  - If **CreateOptions.FILE_NO_INTERMEDIATE_BUFFERING** && **DesiredAccess.FILE_APPEND_DATA**.

- If **DesiredAccess** is zero, the operation MUST be failed with STATUS_ACCESS_DENIED.

- The operation MUST be failed with STATUS_OBJECT_NAME_INVALID under any of the following conditions:

  - If **PathName** is not valid as specified in [MS-FSCC] section 2.1.5.

    - If **PathName** contains a trailing backslash and **CreateOptions.FILE_NON_DIRECTORY_FILE** is TRUE.

- If **DesiredFileAttributes.FILE_ATTRIBUTE_ENCRYPTED** is specified, then the object store MUST set **CreateOptions.FILE_NO_COMPRESSION**.

- Phase 2 -- Volume State:

- If **RootOpen.Volume.IsReadOnly** && (**CreateDisposition** == FILE_CREATE || **CreateDisposition** == FILE_SUPERSEDE || **CreateDisposition** == OVERWRITE || **CreateDisposition** == OVERWRITE_IF) then the operation MUST be failed with STATUS_MEDIA_WRITE_PROTECTED.

- Phase 3 -- Initialization of **Open** Object:

- The object store MUST build a new **Open** object with fields initialized as follows:

  - **Open.RootOpen** set to **RootOpen.**

  - **Open.FileName** formed by concatenating **RootOpen.FileName** + "\" + **FileName**, stripping any redundant backslashes and trailing backslashes.

  - **Open.RemainingDesiredAccess** set to **DesiredAccess**.

  - **Open.SharingMode** set to **ShareAccess**.

  - **Open.Mode** set to (**CreateOptions** & (FILE_WRITE_THROUGH | FILE_SEQUENTIAL_ONLY | FILE_NO_INTERMEDIATE_BUFFERING | FILE_SYNCHRONOUS_IO_ALERT | FILE_SYNCHRONOUS_IO_NONALERT | FILE_DELETE_ON_CLOSE)).

  - **Open.IsCaseInsensitive** set to **IsCaseInsensitive**.

  - **Open.HasBackupAccess** set to TRUE if **SecurityContext.PrivilegeSet** contains "SeBackupPrivilege".

  - **Open.HasRestoreAccess** set to TRUE if **SecurityContext.PrivilegeSet** contains "SeRestorePrivilege".

  - **Open.HasCreateSymbolicLinkAccess** set to TRUE if **SecurityContext.PrivilegeSet** contains "SeCreateSymbolicLinkPrivilege".

  - **Open.HasManageVolumeAccess** set to TRUE if **SecurityContext.PrivilegeSet** contains "SeManageVolumePrivilege".

  - **Open.IsAdministrator** set to TRUE if **SecurityContext.SIDs** contains the well-known SID BUILTIN_ADMINISTRATORS as defined in [MS-DTYP] section 2.4.2.4.

  - **Open.OplockKey** set to **OplockKey**.

  - **Open.LastQuotaId** set to -1.

  - All other fields set to zero.

- Phase 4 -- Check for backup/restore intent

- If **CreateOptions.FILE_OPEN_FOR_BACKUP_INTENT** is set and (**CreateDisposition** == FILE_OPEN || **CreateDisposition** == FILE_OPEN_IF || **CreateDisposition** == FILE_OVERWRITE_IF) and **Open.HasBackupAccess** is TRUE, then the object store SHOULD grant backup access as shown in the following pseudocode:

  - *BackupAccess* = (READ_CONTROL | ACCESS_SYSTEM_SECURITY | FILE_GENERIC_READ | FILE_TRAVERSE)

    - If **Open.RemainingDesiredAccess.MAXIMUM_ALLOWED** is set then:

      - **Open.GrantedAccess** |= *BackupAccess*

    - Else:

      - **Open.GrantedAccess** |= (**Open.RemainingDesiredAccess** & *BackupAccess*)

  - EndIf

  - **Open.RemainingDesiredAccess** &= ~**Open.GrantedAccess**

- If **CreateOptions.FILE_OPEN_FOR_BACKUP_INTENT** is set and **Open.HasRestoreAccess** is TRUE, then the object store SHOULD grant restore access as shown in the following pseudocode:

  - *RestoreAccess* = (WRITE_DAC | WRITE_OWNER | ACCESS_SYSTEM_SECURITY | FILE_GENERIC_WRITE | FILE_ADD_FILE | FILE_ADD_SUBDIRECTORY | DELETE)

    - If **Open.RemainingDesiredAccess.MAXIMUM_ALLOWED** is set then:

      - **Open.GrantedAccess** |= *RestoreAccess*

    - Else:

      - **Open.GrantedAccess** |= (**Open.RemainingDesiredAccess** & *RestoreAccess*)

  - EndIf

  - **Open.RemainingDesiredAccess** &= ~**Open.GrantedAccess**

- Phase 5 -- Parse pathname:

- The object store MUST split **Open.FileName** into pathname components *PathName*$_1$ ... *PathName*$_n$, using the backslash ("\") character as a delimiter. The object store MUST further split each *PathName*$_i$ into a file name component *FileName*$_i$, stream name component *StreamName*$_i$, and stream type name component *StreamTypeName*$_i$, using the colon (":") character as a delimiter (FileNamei:StreamNamei:StreamTypeNamei). If StreamNamei or StreamTypeNamei is not present in the name, the value MUST be set to an empty string.

- If any *StreamTypeName*$_i$ is "$INDEX_ALLOCATION" and the corresponding *StreamName*$_i$ has a value other than an empty string or "$I30", the operation SHOULD be failed with STATUS_INVALID_PARAMETER.

- Phase 6 -- Location of file:

- The object store MUST search for a filename matching **Open.FileName**. If **IsCaseInsensitive** is TRUE, then the search MUST be case-insensitive; otherwise it MUST be case-sensitive. Pseudocode for this search is as follows:

- Set *ParentFile* = **RootOpen.File**.

- // Examine each prefix pathname component in order.

- For i = 1 to n-1: // n is the number of pathname components, from Phase 5.

  - Search *ParentFile*.**DirectoryList** for a **Link** where **Link.Name** or **Link.ShortName** matches *FileName$_i$*, If no such link is found, the operation MUST be failed with STATUS_OBJECT_PATH_NOT_FOUND.

    - If **Link.File.FileType** is not DirectoryFile, the operation MUST be failed with STATUS_NOT_A_DIRECTORY.

    - If **Open.GrantedAccess.FILE_TRAVERSE** is not set and *AccessCheck*(**SecurityContext, Link.File.SecurityDescriptor**, FILE_TRAVERSE) returns FALSE, the operation MAY be failed with STATUS_ACCESS_DENIED.

    - If **Link.IsDeleted**, the operation MUST be failed with STATUS_DELETE_PENDING.

    - If **Link.File.IsSymbolicLink** is TRUE, the operation MUST be failed with **Status** set to STATUS_STOPPED_ON_SYMLINK and **ReparsePointData** set to **Link.File.ReparsePointData**.

    - Set *ParentFile* = **Link.File**.

- EndFor

- // Examine final pathname component.

- Set *FileNameToOpen* to *FileName$_n$*, *StreamNameToOpen* to *StreamName$_n$*, and *StreamTypeNameToOpen* to *StreamTypeName$_n$*.

- Search *ParentFile*.**DirectoryList** for a **Link** where **Link.Name** or **Link.ShortName** matches *FileNameToOpen*. If such a link is found:

- Set **File** = **Link.File**.

  - Set **Open.File** to **File**.

  - Set **Open.Link** to **Link**.

- Else:

  - If (**CreateDisposition ==** FILE_OPEN || **CreateDisposition ==** FILE_OVERWRITE), the operation MUST be failed with STATUS_OBJECT_NAME_NOT_FOUND.

  - If **RootOpen.Volume.IsReadOnly** then the operation MUST be failed with STATUS_MEDIA_WRITE_PROTECTED.

- EndIf

- Phase 7 -- Type of file to open:

- The object store MUST use the following algorithm to determine which type of file is being opened:

- If **CreateOptions.FILE_DIRECTORY_FILE** is TRUE then *FileTypeToOpen* = DirectoryFile.

- Else if **CreateOptions.FILE_NON_DIRECTORY_FILE** is TRUE then *FileTypeToOpen* = DataFile.

- Else if *StreamTypeNameToOpen* is "$INDEX_ALLOCATION" then *FileTypeToOpen* = DirectoryFile.

- Else if *StreamTypeNameToOpen* is "$DATA" then *FileTypeToOpen* = DataFile.

- Else if **Open.File** is not NULL and **Open.File.FileType** is DirectoryFile, then *FileTypeToOpen* = DirectoryFile.

- Else if **PathName** contains a trailing backslash then *FileTypeToOpen* = DirectoryFile.

- Else *FileTypeToOpen* = DataFile.

- If *FileTypeToOpen* is DirectoryFile and **Open.File** is not NULL and **Open.File.FileType** is not DirectoryFile:

- If **CreateDisposition** == FILE_CREATE then the operation MUST be failed with STATUS_OBJECT_NAME_COLLISION, else the operation MUST be failed with STATUS_NOT_A_DIRECTORY.

- EndIf

- If *FileTypeToOpen* is DataFile and *StreamNameToOpen* is empty and **Open.File** is not NULL and **Open.File.FileType** is DirectoryFile, the operation MUST be failed with STATUS_FILE_IS_A_DIRECTORY.

- Phase 8 -- Completion of open

- If **Open.File** is NULL, the object store MUST create a new file as described in section 3.1.5.1.1; otherwise the object store MUST open the existing file as described in section 3.1.5.1.2.

### 3.1.5.1.1   Creation of a New File

Pseudocode for the operation is as follows:

- If *FileTypeToOpen* is DirectoryFile and **DesiredFileAttributes.FILE_ATTRIBUTE_TEMPORARY** is set, the operation MUST be failed with STATUS_INVALID_PARAMETER.

- If **DesiredFileAttributes.FILE_ATTRIBUTE_READONLY** and **CreateOptions.FILE_DELETE_ON_CLOSE** are both set, the operation MUST be failed with STATUS_CANNOT_DELETE.

- If *StreamTypeNameToOpen* is non-empty and has a value other than "$DATA" or "$INDEX_ALLOCATION", the operation MUST be failed with STATUS_ACCESS_DENIED.

- If **Open.RemainingDesiredAccess.ACCESS_SYSTEM_SECURITY** is set and **Open.GrantedAccess.ACCESS_SYSTEM_SECURITY** is not set and **SecurityContext.PrivilegeSet** does not contain "SeSecurityPrivilege", the operation MUST be failed with STATUS_ACCESS_DENIED.

- If *FileTypeToOpen* is DataFile and **Open.GrantedAccess.FILE_ADD_FILE** is not set and *AccessCheck*(**SecurityContext, Open.Link.ParentFile.SecurityDescriptor**, FILE_ADD_FILE) returns FALSE and **Open.HasRestoreAccess** is FALSE, the operation MUST be failed with STATUS_ACCESS_DENIED.

- If *FileTypeToOpen* is DirectoryFile and **Open.GrantedAccess.FILE_ADD_SUBDIRECTORY** is not set and *AccessCheck*(**SecurityContext, Open.Link.ParentFile.SecurityDescriptor**, FILE_ADD_SUBDIRECTORY) returns FALSE and **Open.HasRestoreAccess** is FALSE, the operation MUST be failed with STATUS_ACCESS_DENIED.

- If the object store implements encryption and **DesiredFileAttributes.FILE_ATTRIBUTE_ENCRYPTED** is TRUE:

  - If **UserCertificate** is empty, the operation MUST be failed with **STATUS_CS_ENCRYPTION_NEW_ENCRYPTED_FILE**.

- EndIf

- The object store MUST build a new **File** object with fields initialized as follows:

  - **File.FileType** set to *FileTypeToOpen*.

  - **File.FileID** assigned a new value. The value chosen is implementation-specific but MUST be unique among all files present on **RootOpen.File.Volume**.

  - **File.FileAttributes** set to **DesiredFileAttributes**.

  - **File.CreationTime**, **File.LastModificationTime**, **File.LastChangeTime**, and **File.LastAccessTime** all initialized to the current system time.

  - **File.Volume** set to **RootOpen.File.Volume**.

  - All other fields set to zero.

- The object store MUST build a new **Link** object with fields initialized as follows:

  - **Link.File** set to **File**.

  - **Link.ParentFile** set to *ParentFile*.

  - All other fields set to zero.

- If **File.FileType** is DataFile and **Open.IsCaseInsensitive** is TRUE, and tunnel caching is implemented, the object store MUST search **File.Volume.TunnelCacheList** for a *TunnelCacheEntry* where *TunnelCacheEntry***.ParentFile** equals **Link.ParentFile** and either (*TunnelCacheEntry***.KeyByShortName** is FALSE and *TunnelCacheEntry***.FileName** matches *FileNameToOpen*) or (*TunnelCacheEntry***.KeyByShortName** is TRUE and *TunnelCacheEntry***.FileShortName** matches *FileNameToOpen*). If such an entry is found, then:

  - Set **File.CreationTime** to *TunnelCacheEntry***.FileCreationTime**.

  - Set **File.ObjectId** to *TunnelCacheEntry***.FileObjectId**.

  - Set **Link.Name** to *TunnelCacheEntry***.FileName**.

  - Set **Link.ShortName** to *TunnelCacheEntry***.FileShortName** if that name is not already in use among all names and short names in **Link.ParentFile.DirectoryList**.

  - Remove *TunnelCacheEntry* from **File.Volume.TunnelCacheList**.

- Else:

  - Set **Link.Name** to *FileNameToOpen*.

- EndIf

- If short names are enabled and **Link.ShortName** is empty, then the object store MUST create a short name as follows:

- If **Link.Name** is 8.3-compliant as described in [MS-FSCC] section 2.1.5.2.1:

  - Set **Link.ShortName** to **Link.Name**.

- Else:

  - Generate a new **Link.ShortName** that is 8.3-compliant as described in [MS-FSCC] section 2.1.5.2.1. The string chosen is implementation-specific, but MUST be unique among all names and short names present in **Link.ParentFile.DirectoryList**.

- EndIf

- EndIf

- The object store MUST now grant the full requested access, as shown by the following pseudocode:

  - If **Open.RemainingDesiredAccess.MAXIMUM_ALLOWED** is set:

    - **Open.GrantedAccess** |= FILE_ALL_ACCESS

  - Else:

    - **Open.GrantedAccess** |= **Open.RemainingDesiredAccess**

  - EndIf

  - **Open.RemainingDesiredAccess** = 0

- The object store MUST initialize **File.SecurityDescriptor.Dacl** to **SecurityContext.DefaultDACL**. The object store SHOULD append any inheritable security information from **Link.ParentFile.SecurityDescriptor** to **File.SecurityDescriptor**.

- The object store MUST set **File.FileAttributes.FILE_ATTRIBUTE_NOT_CONTENT_INDEXED** to the value of **Link.ParentFile.FileAttributes.FILE_ATTRIBUTE_NOT_CONTENT_INDEXED**.

- The object store MUST clear any attribute flags from **File.FileAttributes** that cannot be directly set by applications, as follows:

  - *ValidSetAttributes* = (FILE_ATTRIBUTE_READONLY | FILE_ATTRIBUTE_HIDDEN | FILE_ATTRIBUTE_SYSTEM | FILE_ATTRIBUTE_ARCHIVE | FILE_ATTRIBUTE_TEMPORARY | FILE_ATTRIBUTE_OFFLINE | FILE_ATTRIBUTE_NOT_CONTENT_INDEXED)

  - **File.FileAttributes** &= *ValidSetAttributes*

- If **File.FileType** is DataFile, then the object store MUST set **File.FileAttributes.FILE_ATTRIBUTE_ARCHIVE**.

- If **File.FileType** is DirectoryFile, then the object store MUST set **File.FileAttributes.FILE_ATTRIBUTE_DIRECTORY**.

- If **Link.ParentFile.FileAttributes.FILE_ATTRIBUTE_ENCRYPTED** or **DesiredFileAttributes.FILE_ATTRIBUTE_ENCRYPTED** is set, then the object store MUST set **File.FileAttributes.FILE_ATTRIBUTE_ENCRYPTED**.

- ▪ If **Link.ParentFile.FileAttributes.FILE_ATTRIBUTE_COMPRESSED** is set and **CreateOptions.FILE_NO_COMPRESSION** is not set, then the object store MUST set **File.FileAttributes.FILE_ATTRIBUTE_COMPRESSED**.

- ▪ If the object store implements encryption and **File.FileAttributes.FILE_ATTRIBUTE_ENCRYPTED** is TRUE, insert **UserCertificate** into **File.UserCertificateList**.

- ▪ If **File.FileType** is DataFile and *StreamNameToOpen* is not empty, then the object store MUST create a default unnamed stream for the file as follows:

  - ▪ Build a new **Stream** object **DefaultStream** with all fields initially set to zero.

    - ▪ Set **DefaultStream.File** to **File**.

    - ▪ If the object store implements encryption and **File.FileAttributes.FILE_ATTRIBUTE_ENCRYPTED** is TRUE, set **DefaultStream.IsEncrypted** to TRUE.

    - ▪ Add **DefaultStream** to **File.StreamList**.

- ▪ EndIf

- ▪ If *StreamTypeNameToOpen* is empty or "$DATA", then the object store MUST create a new data stream for the file as follows:

  - ▪ Build a new **Stream** object with all fields initially set to zero.

  - ▪ Set **Stream.StreamType** to DataStream.

  - ▪ Set **Stream.Name** to *StreamNameToOpen*.

  - ▪ Set **Stream.File** to **File**.

  - ▪ Add **Stream** to **File.StreamList**.

  - ▪ Set **Open.Stream** to **Stream**.

- ▪ Else the object store MUST create a new directory stream as follows:

  - ▪ Build a new **Stream** object with all fields initially set to zero.

  - ▪ Set **Stream.StreamType** to DirectoryStream.

  - ▪ Set **Stream.File** to **File**.

  - ▪ Add **Stream** to **File.StreamList**.

  - ▪ Set **Open.Stream** to **Stream**.

- ▪ EndIf

- ▪ If the object store implements encryption and **File.FileAttributes.FILE_ATTRIBUTE_ENCRYPTED** is TRUE:

  - ▪ If **File.FileType** is DataFile, set **Stream.IsEncrypted** to TRUE.

- ▪ EndIf

- The object store MUST set **Open.File** to **File**.

- The object store MUST set **Open.Link** to **Link**.

- The object store MUST insert **Link** into **File.LinkList**.

- The object store MUST insert **Link** into **Link.ParentFile.DirectoryList**.

- The object store MUST update **Link.ParentFile.LastModificationTime**, **Link.ParentFile.LastChangeTime**, and **Link.ParentFile.LastAccessTime** to the current system time.

- The object store MUST insert **File** into **File.Volume.OpenFileList**.

- The object store MUST insert **Open** into **File.OpenList**.

- If **File.FileType** is DirectoryFile:

  - *FilterMatch* = FILE_NOTIFY_CHANGE_DIR_NAME

- Else:

  - *FilterMatch* = FILE_NOTIFY_CHANGE_FILE_NAME

- EndIf

- The object store MUST send directory change notification as per section 3.1.4.1 with **Volume** equal to **File.Volume**, **Action** equal to FILE_ACTION_ADDED, **FilterMatch** equal to *FilterMatch*, and **FileName** equal to **Open.FileName**.

- The object store MUST return:

  - **Status** set to STATUS_SUCCESS.

  - **CreateAction** set to FILE_CREATED.

  - The **Open** object created previously.

### 3.1.5.1.2   Open of an Existing File

Files that require knowledge of extended attributes cannot be opened by applications that do not understand extended attributes. If **CreateOptions.FILE_NO_EA_KNOWLEDGE** is set and (*FileTypeToOpen* is DirectoryFile or (*FileTypeToOpen* is DataFile and *StreamNameToOpen* is empty)) and **File.ExtendedAttributes** contains an *ExistingEa* where *ExistingEa*.**Flags.FILE_NEED_EA** is set, the operation MUST be failed with STATUS_ACCESS_DENIED.

Pseudocode for the operation is as follows:

- If **CreateOptions.FILE_OPEN_REPARSE_POINT** is not set and **File.ReparsePointTag** is not empty, then the operation MUST be failed with **Status** set to STATUS_REPARSE and **ReparsePointData** set to **File.ReparsePointData**.

- If *FileTypeToOpen* is DirectoryFile:

  - If **CreateDisposition** is FILE_OPEN or FILE_OPEN_IF then:

    - Perform access checks as described in section 3.1.5.1.2.1. If this fails, the request MUST be failed with the same status.

- Perform sharing access checks as described in section 3.1.5.1.2.2. If this fails, the request MUST be failed with the same status.

- Set **CreateAction** to FILE_OPENED.

- Else:

  - // Existing directories cannot be overwritten/superseded.

  - If **File** == **File.Volume.RootDirectory**, then the operation MUST be failed with STATUS_ACCESS_DENIED, else the operation MUST be failed with STATUS_OBJECT_NAME_COLLISION.

- EndIf

- Else if *FileTypeToOpen* is DataFile:

  - The object store MUST search **File.StreamList** for a **Stream** with **Stream.Name** matching *StreamNameToOpen*. If **IsCaseInsensitive** is TRUE, then the search MUST be case-insensitive; otherwise it MUST be case-sensitive.

  - If **Stream** was found:

    - Set **Open.Stream** to **Stream**.

    - If **CreateDisposition** is FILE_CREATE, then the operation MUST be failed with STATUS_OBJECT_NAME_COLLISION.

    - If **CreateDisposition** is FILE_OPEN or FILE_OPEN_IF:

      - If **Open.Stream.Oplock** is not empty and **Open.Stream.Oplock.State** contains BATCH_OPLOCK, the object store MUST check for an oplock break according to the algorithm in section 3.1.4.12, with input values as follows:

        - **Open** equal to this operation's **Open**

        - **Operation** equal to "OPEN"

        - **OpParams** containing two members:

          - **DesiredAccess** equal to this operation's **DesiredAccess**

          - **CreateDisposition** equal to this operation's **CreateDisposition**

      - Perform access checks as described in section 3.1.5.1.2.1. If this fails with STATUS_SHARING_VIOLATION:

        - If **Open.Stream.Oplock** is not empty and **Open.Stream.Oplock.State** contains HANDLE_CACHING, the object store MUST check for an oplock break according to the algorithm in section 3.1.4.12, with input values as follows:

          - **Open** equal to this operation's **Open**

          - **Operation** equal to "OPEN_BREAK_H"

        - Perform access checks as described in section 3.1.5.1.2.1. If this fails, the request MUST be failed with the same status.

      - EndIf

- Perform sharing access checks as described in section 3.1.5.1.2.2. If this fails with STATUS_SHARING_VIOLATION:

    - If **Open.Stream.Oplock** is not empty and **Open.Stream.Oplock.State** contains HANDLE_CACHING, the object store MUST check for an oplock break according to the algorithm in section 3.1.4.12, with input values as follows:

        - **Open** equal to this operation's **Open**

        - **Operation** equal to "OPEN_BREAK_H"

    - Perform sharing access checks as described in section 3.1.5.1.2.2. If this fails, the request MUST be failed with the same status.

- EndIf

- Set **CreateAction** to FILE_OPENED.

- Else:

    - If **File.Volume.IsReadOnly** is TRUE, the operation MUST be failed with STATUS_MEDIA_WRITE_PROTECTED.

    - If **Open.Stream.Oplock** is not empty and **Open.Stream.Oplock.State** contains BATCH_OPLOCK, the object store MUST check for an oplock break according to the algorithm in section 3.1.4.12, with input values as follows:

        - **Open** equal to this operation's **Open**

        - **Operation** equal to "OPEN"

        - **OpParams** containing two members:

            - **DesiredAccess** equal to this operation's **DesiredAccess**

            - **CreateDisposition** equal to this operation's **CreateDisposition**

    - If **Stream.Name** is empty:

        - If **File.FileAttributes**.FILE_ATTRIBUTE_HIDDEN is TRUE and **DesiredFileAttributes**.FILE_ATTRIBUTE_HIDDEN is FALSE, then the operation MUST be failed with STATUS_ACCESS_DENIED.

        - If **File.FileAttributes**.FILE_ATTRIBUTE_SYSTEM is TRUE and **DesiredFileAttributes**.FILE_ATTRIBUTE_SYSTEM is FALSE, then the operation MUST be failed with STATUS_ACCESS_DENIED.

        - Set **DesiredFileAttributes**.FILE_ATTRIBUTE_ARCHIVE to TRUE.

        - Set **DesiredFileAttributes**.FILE_ATTRIBUTE_NORMAL to FALSE.

        - Set **DesiredFileAttributes**.FILE_ATTRIBUTE_NOT_CONTENT_INDEXED to FALSE.

        - If **File.FileAttributes**.FILE_ATTRIBUTE_ENCRYPTED is TRUE, then set **DesiredFileAttributes**.FILE_ATTRIBUTE_ENCRYPTED to TRUE.

- If **Open.HasRestoreAccess** is TRUE, then the object store MUST set **Open.GrantedAccess**.FILE_WRITE_EA to TRUE. Otherwise, the object store MUST set **Open.RemainingDesiredAccess**.FILE_WRITE_EA to TRUE.

- If **Open.HasRestoreAccess** is TRUE, then the object store MUST set **Open.GrantedAccess**.FILE_WRITE_ATTRIBUTES to TRUE. Otherwise, the object store MUST set **Open.RemainingDesiredAccess**.FILE_WRITE_ATTRIBUTES to TRUE.

- EndIf

- If **CreateDisposition** is FILE_SUPERSEDE:

  - If **Open.HasRestoreAccess** is TRUE, then the object store MUST set **Open.GrantedAccess**.DELETE to TRUE. Otherwise, the object store MUST set **Open.RemainingDesiredAccess**.DELETE to TRUE.

- Else:

  - If **Open.HasRestoreAccess** is TRUE, then the object store MUST set **Open.GrantedAccess**.FILE_WRITE_DATA to TRUE. Otherwise, the object store MUST set **Open.RemainingDesiredAccess**.FILE_WRITE_DATA to TRUE.

- EndIf

- **Open.RemainingDesiredAccess** &= ~**Open.GrantedAccess**

- Perform access checks as described in section 3.1.5.1.2.1. If this fails with STATUS_SHARING_VIOLATION:

  - If **Open.Stream.Oplock** is not empty and **Open.Stream.Oplock.State** contains HANDLE_CACHING, the object store MUST check for an oplock break according to the algorithm in section 3.1.4.12, with input values as follows:

    - **Open** equal to this operation's **Open**

    - **Operation** equal to "OPEN_BREAK_H"

  - Perform access checks as described in section 3.1.5.1.2.1. If this fails, the request MUST be failed with the same status.

- EndIf

- Perform sharing access checks as described in section 3.1.5.1.2.2. If this fails with STATUS_SHARING_VIOLATION:

  - If **Open.Stream.Oplock** is not empty and **Open.Stream.Oplock.State** contains HANDLE_CACHING, the object store MUST check for an oplock break according to the algorithm in section 3.1.4.12, with input values as follows:

    - **Open** equal to this operation's **Open**

    - **Operation** equal to "OPEN_BREAK_H"

  - Perform sharing access checks as described in section 3.1.5.1.2.2. If this fails, the request MUST be failed with the same status.

- EndIf

- Update **File.LastModificationTime** to the current system time.

- If **CreateDisposition** is FILE_SUPERSEDE, the object store MUST set **CreateAction** to FILE_SUPERSEDED; otherwise, it MUST set **CreateAction** to FILE_OVERWRITTEN.

- EndIf

- Else: // **Stream** not found.

- If **CreateDisposition** is FILE_OPEN or FILE_OVERWRITE, the operation MUST be failed with STATUS_OBJECT_NAME_NOT_FOUND.

- If **Open.GrantedAccess**.FILE_WRITE_DATA is not set and **Open.RemainingDesiredAccess**.FILE_WRITE_DATA is not set:

- If **Open.HasRestoreAccess** is TRUE, then the object store MUST set **Open.GrantedAccess**.FILE_WRITE_DATA to TRUE; otherwise, the object store MUST set **Open.RemainingDesiredAccess**.FILE_WRITE_DATA to TRUE.

- EndIf

- Perform access checks as described in section [3.1.5.1.2.1](#). If this fails, the request MUST be failed with the same status.

- If **File.Volume.IsReadOnly** is TRUE, the operation MUST be failed with STATUS_MEDIA_WRITE_PROTECTED.

- Build a new **Stream** object with all fields initially set to zero.

- Set **Stream.StreamType** to DataStream.

- Set **Stream.Name** to *StreamNameToOpen*.

- Set **Stream.File** to **File**.

- Add **Stream** to **File.StreamList**.

- Set **Open.Stream** to **Stream**.

- Set **CreateAction** to FILE_CREATED.

- EndIf.

- EndIf

- If the object store implements encryption:

- If (**CreateAction** is FILE_OVERWRITTEN or FILE_SUPERSEDED) and (**Stream.Name** is empty) and (**DesiredFileAttributes**.FILE_ATTRIBUTE_ENCRYPTED is TRUE) and (**File.FileAttributes**.FILE_ATTRIBUTE_ENCRYPTED is FALSE), then:

- If **File.OpenList** is non-empty, then the operation MUST be failed with STATUS_SHARING_VIOLATION.

- EndIf

- EndIf

- If **CreateAction** is one of FILE_OVERWRITTEN or FILE_SUPERSEDED, then:

- If **Stream.Name** is empty:

    - Set **File.FileAttributes** to **DesiredFileAttributes**.

- EndIf

- EndIf

- If the object store implements encryption and
  **File.FileAttributes.FILE_ATTRIBUTE_ENCRYPTED** is TRUE:

    - If **CreateAction** is FILE_OPENED:

        - If **Stream.IsEncrypted** is TRUE:

            - If **UserCertificate** is empty, the operation MUST be failed with
              STATUS_CS_ENCRYPTION_EXISTING_ENCRYPTED_FILE.

            - If **UserCertificate** is not in **File.UserCertificateList**, the operation MUST be failed with
              STATUS_ACCESS_DENIED.

        - EndIf

    - Else:  // we are creating, overwriting, or superseding a stream

        - If **UserCertificate** is empty, the operation MUST be failed with
          STATUS_CS_ENCRYPTION_NEW_ENCRYPTED_FILE.

        - If **Stream.Name** is empty:

            - If **File.UserCertificateList** is empty, insert **UserCertificate** into
              **File.UserCertificateList**.

        - Else:

            - If **UserCertificate** is not in **File.UserCertificateList**, the operation MUST be failed with
              STATUS_ACCESS_DENIED.

        - EndIf

        - If **File.FileType** is DataFile, set **Stream.IsEncrypted** to TRUE.

    - EndIf

- EndIf

- If **CreateAction** is one of FILE_CREATED, FILE_OVERWRITTEN or FILE_SUPERSEDED, then:

    - The object store MUST set *FilterMatch* to a set of flags capturing modifications to the existing
      file's persistent attributes performed during the Open operation.

    - Send directory change notification as per section 3.1.4.1, with **Volume** equal to **File.Volume**,
      **Action** equal to FILE_ACTION_MODIFIED, **FilterMatch** equal to *FilterMatch*, and **FileName**
      equal to **Open.FileName**.

- EndIf

- If **CreateAction** is FILE_CREATED, then the object store MUST insert **Stream** into
  **File.StreamList**.

- If **File** is not in **File.Volume.OpenFileList**, the object store MUST insert it.

- The object store MUST insert **Open** into **File.OpenList**.

- The object store MUST return:

  - **Status** set to STATUS_SUCCESS.

  - **CreateAction** set to FILE_OPENED.

  - The **Open** object created previously.

### 3.1.5.1.2.1   Algorithm to Check Access to an Existing File

The inputs to the algorithm are:

- **Open:** The **Open** for an in-progress Open operation to an existing file.

On completion, the algorithm returns:

- **Status:** An NTSTATUS code that specifies the result of the access check.

This object store MUST perform access checks when opening an existing file, making use of the file's security descriptor and possibly the parent file's security descriptor.

Pseudocode for these checks is as follows:

- If **Open.File.FileType** is DataFile and (**File.FileAttributes**.FILE_ATTRIBUTE_READONLY && (**DesiredAccess**.FILE_WRITE_DATA || **DesiredAccess**.FILE_APPEND_DATA)), then return STATUS_ACCESS_DENIED.

- If ((**File.FileAttributes**.FILE_ATTRIBUTE_READONLY || **File.Volume.IsReadOnly**) && **CreateOptions.**FILE_DELETE_ON_CLOSE), then return STATUS_CANNOT_DELETE.

- If **Open.RemainingDesiredAccess** is nonzero:

  - If **Open.RemainingDesiredAccess**.MAXIMUM_ALLOWED is TRUE:

    - For each *Access* Flag in FILE_ALL_ACCESS, the object store MUST set **Open.GrantedAccess.***Access* if ***AccessCheck***(**SecurityContext, File.SecurityDescriptor**, *Access*) returns TRUE.

    - If **File.FileAttributes.**FILE_ATTRIBUTE_READONLY or **File.Volume.IsReadOnly**, then the object store MUST clear (FILE_WRITE_DATA | FILE_APPEND_DATA | FILE_ADD_SUBDIRECTORY | FILE_DELETE_CHILD) from **Open.GrantedAccess**.

  - Else:

    - For each *Access* Flag in **Open.RemainingDesired**.*Access*, the object store MUST set **Open.GrantedAccess**.*Access* if ***AccessCheck***(**SecurityContext, File.SecurityDescriptor**, *Access*) returns TRUE.

  - EndIf

  - If (**Open.RemainingDesiredAccess**.MAXIMUM_ALLOWED || **Open.RemainingDesiredAccess.**DELETE), the object store MUST set **Open.GrantedAccess.**DELETE if ***AccessCheck***(**SecurityContext, Open.Link.ParentFile.SecurityDescriptor**, FILE_DELETE_CHILD) returns TRUE.

- If (**Open.RemainingDesiredAccess**.MAXIMUM_ALLOWED ||
  **Open.RemainingDesiredAccess.**FILE_READ_ATTRIBUTES), the object store MUST set
  **Open.GrantedAccess.**FILE_READ_ATTRIBUTES if *AccessCheck*(**SecurityContext,
  Open.Link.ParentFile.SecurityDescriptor**, FILE_LIST_DIRECTORY) returns TRUE.

  - **Open.RemainingDesiredAccess** &= ~(**Open.GrantedAccess** | MAXIMUM_ALLOWED)

  - If **Open.RemainingDesiredAccess** is nonzero, then return STATUS_ACCESS_DENIED.

- EndIf

Since deletion of a file's primary stream implies deletion of the entire file, including any **alternate
data streams**, the object store MUST check for sharing conflicts involving deletion of the primary
stream and the sharing modes of all opens to the file.

Pseudocode for these checks is as follows:

- If **Open.SharingMode**.FILE_SHARE_DELETE is FALSE and **Open.GrantedAccess** contains any
  one or more of (FILE_EXECUTE | FILE_READ_DATA | FILE_WRITE_DATA | FILE_APPEND_DATA):

  - For each *ExistingOpen* is **Open.File.OpenList**:

    - If *ExistingOpen*.**Mode**.FILE_DELETE_ON_CLOSE is TRUE and
      (*ExistingOpen*.**Stream.StreamType** is DirectoryStream or *ExistingOpen*.**Stream.Name** is
      empty), then return STATUS_SHARING_VIOLATION.

  - EndFor

- EndIf

- If **Open.GrantedAccess**.DELETE is TRUE and (**Open.Stream.StreamType** is DirectoryStream
  or **Open.Stream.Name** is empty):

  - For each *ExistingOpen* in **Open.File.OpenList**:

    - If *ExistingOpen*.**SharingMode**.FILE_SHARE_DELETE is FALSE, then return
      STATUS_SHARING_VIOLATION.

  - EndFor

- EndIf

- Return STATUS_SUCCESS.

### 3.1.5.1.2.2   Algorithm to Check Sharing Access to an Existing Stream or Directory

The inputs to the algorithm are:

- **Open:** The **Open** for an in-progress Open operation to an existing stream or directory.

On completion, the algorithm returns:

- **Status:** An NTSTATUS code that specifies the result of the sharing check.

The object store MUST perform sharing checks when opening an existing stream or directory.

Pseudocode for these checks is as follows:

- If *AccessCheck*(**SecurityContext, Open.Link.ParentFile.SecurityDescriptor**, FILE_WRITE_DATA) returns FALSE, the object store MUST set **Open.SharingMode**.FILE_SHARE_READ to TRUE.

- If **DesiredAccess** contains any of (FILE_READ_DATA | FILE_EXECUTE | FILE_WRITE_DATA | FILE_APPEND_DATA | DELETE):

  - For each *ExistingOpen* in **Open.File.OpenList**:

    - If *ExistingOpen*.**Stream** equals **Open.Stream** and *ExistingOpen*.**GrantedAccess** contains any of (FILE_READ_DATA | FILE_EXECUTE | FILE_WRITE_DATA | FILE_APPEND_DATA | DELETE), then return STATUS_SHARING_VIOLATION under any of the following conditions:

      - If *ExistingOpen*.**SharingMode**.FILE_SHARE_READ is FALSE and **DesiredAccess** contains either FILE_READ_DATA or FILE_EXECUTE

      - If *ExistingOpen*.**SharingMode**.FILE_SHARE_WRITE is FALSE and **DesiredAccess** contains either FILE_WRITE_DATA or FILE_APPEND_DATA

      - If *ExistingOpen*.**SharingMode**.FILE_SHARE_DELETE is FALSE and *ExistingOpen* contains DELETE

      - If **Open.SharingMode**.FILE_SHARE_READ is FALSE and *ExistingOpen*.**GrantedAccess** contains either FILE_READ_DATA or FILE_EXECUTE

      - If **Open.SharingMode**.FILE_SHARE_WRITE is FALSE and *ExistingOpen*.**GrantedAccess** contains either FILE_WRITE_DATA or FILE_APPEND_DATA

      - If **Open.SharingMode**.FILE_SHARE_READ is FALSE and *ExistingOpen*.**GrantedAccess** contains DELETE

    - EndIf

  - EndFor

- EndIf

- If **Open.Stream.StreamType** is DataStream:

  - If **Open.Stream.Oplock** is not empty, the object store MUST check for an oplock break according to the algorithm in section 3.1.4.12, with input values as follows:

    - **Open** equal to this operation's **Open**

    - **Operation** equal to "OPEN"

    - **OpParams** containing two members:

      - **DesiredAccess** equal to this operation's **DesiredAccess**

      - **CreateDisposition** equal to this operation's **CreateDisposition**

  - EndIf

  - Return STATUS_SUCCESS.

*Release: Friday, February 4, 2011*

### 3.1.5.2  Server Requests a Read

The server provides:

- **Open:** The **Open** of the DataFile to read from.

- **ByteOffset:** The absolute byte offset in the stream from which to read data.

- **ByteCount:** The requested number of bytes to read.

On completion, the object store MUST return:

- **Status:** An NTSTATUS code that specifies the result.

- **OutputBuffer:** An array of bytes that were read.

- **BytesRead:** The number of bytes that were read.

Pseudocode for the operation is as follows:

- If **Open.Mode.FILE_NO_INTERMEDIATE_BUFFERING** is TRUE & (**ByteOffset** >= 0), the operation MUST be failed with STATUS_INVALID_PARAMETER under any of the following conditions:

    - (**ByteOffset** % **Open.File.Volume.SectorSize**) is not zero.

    - (**ByteCount** % **Open.File.Volume.SectorSize**) is not zero.

- If **ByteOffset** is negative, then the operation MUST be failed with STATUS_INVALID_PARAMETER.

- If (**ByteOffset** + **ByteCount**) is larger than MAXLONGLONG (0x7fffffffffffffff), the operation MUST be failed with STATUS_INVALID_PARAMETER.

- If **ByteCount** is zero, the object store MUST return:

    - **BytesRead** set to zero.

    - **Status** set to STATUS_SUCCESS.

- Set *RequestedByteCount* to **ByteCount**.

- If **Open.Stream.Oplock** is not empty, the object store MUST check for an oplock break according to the algorithm in section 3.1.4.12, with input values as follows:

    - **Open** equal to this operation's **Open**

    - **Operation** equal to "READ"

    - **OpParams** empty

- Determine if the read is in conflict with an existing byte range lock on **Open.Stream** using the algorithm described in section 3.1.4.10 (with **ByteOffset** set to **ByteOffset**, **Length** set to **ByteCount**, **IsExclusive** set to FALSE, **LockIntent** set to FALSE and **Open** set to **Open**). If the algorithm returns TRUE, the operation MUST be failed with STATUS_FILE_LOCK_CONFLICT.

- If **ByteOffset** >= **Open.Stream.Size**, the operation MUST be failed with STATUS_END_OF_FILE.

- If (**ByteOffset** + **ByteCount**) >= **Open.Stream.Size**, truncate **ByteCount** to (**Open.Stream.Size** - **ByteOffset**) and then set *RequestedByteCount* to **ByteCount**.

- If **Open.Mode.FILE_NO_INTERMEDIATE_BUFFERING** is TRUE:

    - The object store MUST write any unwritten cached data for this range of the stream to disk.

    - The object store MUST remove from the cache any cached data for this range of the stream.

    - If (**ByteOffset** >= **Open.Stream.ValidDataLength**):

        - If **Open.Mode.FILE_SYNCHRONOUS_IO_ALERT** is TRUE or **Open.Mode.FILE_SYNCHRONOUS_IO_NONALERT** is TRUE, the object store MUST set **Open.CurrentByteOffset** to (**ByteOffset** + **ByteCount**).

        - The object store MUST return:

            - **BytesRead** set to **ByteCount**.

            - **OutputBuffer** filled with **ByteCount** zero(s).

            - **Status** set to STATUS_SUCCESS.

        - EndIf

    - If ((**ByteOffset** + **ByteCount**) >= **Open.Stream.ValidDataLength**), truncate **ByteCount** to (**Open.Stream.ValidDataLength** - **ByteOffset**).

    - Set *BytesToRead* to ***BlockAlign***(**ByteCount, Open.File.Volume.SectorSize**).

    - Read *BytesToRead* bytes from the disk at offset **ByteOffset** for this stream into **OutputBuffer**. If the read from the disk failed, the operation MUST be failed with the same error status**.**

    - If *RequestedByteCount* > **ByteCount**, zero out **OutputBuffer** between **ByteCount** and *RequestedByteCount*.

    - If **Open.Mode.FILE_SYNCHRONOUS_IO_ALERT** is TRUE or **Open.Mode.FILE_SYNCHRONOUS_IO_NONALERT** is TRUE, the object store MUST set **Open.CurrentByteOffset** to (**ByteOffset** + *RequestedByteCount*).

    - Upon successful completion of the operation, the object store MUST return:

        - **BytesRead** set to *RequestedByteCount*.

        - **Status** set to STATUS_SUCCESS.

    - Else

        - Read **ByteCount** bytes at offset **ByteOffset** from the cache for this stream into **OutputBuffer**.

        - If **Open.Mode.FILE_SYNCHRONOUS_IO_ALERT** is TRUE or **Open.Mode.FILE_SYNCHRONOUS_IO_NONALERT** is TRUE, the object store MUST set **Open.CurrentByteOffset** to (**ByteOffset** + **ByteCount**).

        - Upon successful completion of the operation, the object store MUST return:

            - **BytesRead** set to **ByteCount**.

- ▪ **Status** set to STATUS_SUCCESS.

  - ▪ EndIf

### 3.1.5.3 Server Requests a Write

The server provides:

- ▪ **Open:** The **Open** of the DataFile to write to.

- ▪ **InputBuffer:** An array of bytes to write.

- ▪ **ByteOffset:** The absolute byte offset in the stream where data should be written. **ByteOffset** could be negative, which means the write should occur at the end of the stream.

- ▪ **ByteCount:** The number of bytes in **InputBuffer** to write.

On completion, the object store MUST return:

- ▪ **Status:** An NTSTATUS code that specifies the result.

- ▪ **BytesWritten:** The number of bytes written.

Pseudocode for the operation is as follows:

- ▪ If **Open.Mode.FILE_NO_INTERMEDIATE_BUFFERING** is TRUE and (**ByteOffset** >= 0), the operation MUST be failed with STATUS_INVALID_PARAMETER under any of the following conditions:

  - ▪ If (**ByteOffset** % **Open.File.Volume.SectorSize**) is not zero.

  - ▪ If (**ByteCount** % **Open.File.Volume.SectorSize**) is not zero.

- ▪ If **ByteOffset** equals -2, then set ByteOffset to **Open.CurrentByteOffset**.

- ▪ If **Open.File.Volume.IsReadOnly**, the operation MUST be failed with STATUS_MEDIA_WRITE_PROTECTED.

- ▪ If ((**ByteOffset** + **ByteCount**) > MAXLONGLONG (0x7fffffffffffffff) and (**ByteOffset** >= 0), the operation MUST be failed with STATUS_INVALID_PARAMETER.

- ▪ If **ByteCount** is zero, the object store MUST return:

  - ▪ **BytesWritten** set to 0.

  - ▪ **Status** set to STATUS_SUCCESS.

- ▪ If ((**ByteOffset** < 0) and (**Open.Stream.Size + ByteCount)**) > MAXLONGLONG (0x7fffffffffffffff), the operation MUST fail with STATUS_INVALID_PARAMETER.

- ▪ If (**ByteOffset** < 0), set **ByteOffset** to **Open.Stream.Size**.

- ▪ If (**ByteOffset** + **ByteCount**) > MAXFILESIZE (0xffffffff0000), the operation MUST be failed with STATUS_INVALID_PARAMETER.

- ▪ Initialize *UsnReason* to zero.

- ▪ If (**ByteOffset** + **ByteCount**) > **Open.Stream.Size**, set *UsnReason*.USN_REASON_DATA_EXTEND to TRUE.

- If **ByteOffset** < **Open.Stream.Size**, set *UsnReason*.USN_REASON_DATA_OVERWRITE to TRUE.

- If **Open.Stream.Oplock** is not empty, the object store MUST check for an oplock break according to the algorithm in section 3.1.4.12, with input values as follows:

  - **Open** equal to this operation's **Open**

  - **Operation** equal to "WRITE"

  - **OpParams** empty

- Determine if the write is in conflict with an existing byte range lock on **Open.Stream** using the algorithm described in section 3.1.4.10 (with **ByteOffset** set to **ByteOffset**, **Length** set to **ByteCount**, **IsExclusive** set to TRUE, **LockIntent** set to FALSE and **Open** set to **Open**). If the algorithm returns TRUE, the operation MUST be failed with STATUS_FILE_LOCK_CONFLICT.

- The object store MUST post a USN change as per section 3.1.4.11 with **File** equal to **File**, **Reason** equal to *UsnReason*, and **FileName** equal to **Open.Link.Name**.

- If ((**ByteOffset** + **ByteCount**) > **Open.Stream.ValidDataLength**), then set *DoingIoAtEof* to TRUE.

- If ((**ByteOffset** + **ByteCount**) > **Open.Stream.AllocationSize**), the object store MUST increase **Open.Stream.AllocationSize** to *BlockAlign*(**ByteOffset** + **ByteCount**, **Open.File.Volume.ClusterSize**). If there is not enough disk space, the operation MUST be failed with STATUS_DISK_FULL.

- If **Open.Mode.FILE_NO_INTERMEDIATE_BUFFERING** is TRUE:

  - The object store MUST write any unwritten cached data for this range of the stream to disk.

  - The object store MUST remove from the cache any cached data for this range of the stream.

  - If *DoingIoAtEof* is TRUE, and (**Open.Stream.ValidDataLength** < **ByteOffset**) , write zeroes to the location on disk corresponding to the range between **Open.Stream.ValidDataLength** and **ByteOffset** in the stream, and then write the first **ByteCount** bytes of **InputBuffer** to the location on disk corresponding to the range starting at offset **ByteOffset** in the stream. If either write to the disk failed, the operation MUST be failed with the corresponding error status.

- EndIf

- If **Open.Mode.FILE_NO_INTERMEDIATE_BUFFERING** is FALSE, *DoingIoAtEof* is TRUE, and (**Open.Stream.ValidDataLength** < **ByteOffset**), zero out the range between **Open.Stream.ValidDataLength** and **ByteOffset** in the cache for this stream and then write the first **ByteCount** bytes of **InputBuffer** into the cache for this stream at offset **ByteOffset**. If there would not be enough disk space to flush the cache, the operation MUST be failed with STATUS_DISK_FULL. If **Open.Mode.FILE_WRITE_THROUGH** is TRUE, the cache write will also trigger a flush of the cache for that range to the disk.

- If **Open.Mode.FILE_SYNCHRONOUS_IO_ALERT** is TRUE or **Open.Mode.FILE_SYNCHRONOUS_IO_NONALERT** is TRUE, the object store MUST set **Open.CurrentByteOffset** to (**ByteOffset** + **ByteCount**).

- Upon successful completion of the operation, the object store MUST set:

  - **Open.Stream.Size** to the maximum of **Open.Stream.Size** or (**ByteOffset** + **ByteCount**).

- **Open.Stream.ValidDataLength** to the maximum of **Open.Stream.ValidDataLength** or (**ByteOffset** + **ByteCount**).

- **BytesWritten** to **ByteCount**.

- **Status** to STATUS_SUCCESS.

### 3.1.5.4  Server Requests Closing an Open

The server provides:

- **Open:** The **Open** that the application is to close.

On completion, the object store MUST return:

- **Status:** An NTSTATUS code that specifies the result.

This operation uses the following local variables:

- Boolean values (initialized to FALSE): *LinkDeleted*, *StreamDeleted*, *FileDeleted*, *PostUsnClose*

The **Open** provided by the application MUST be removed from **Open.File.OpenList**.

Pseudocode for the operation is as follows:

- Phase 1 - Delete on Close:

- If **Open.Mode.FILE_DELETE_ON_CLOSE** is TRUE:

    - If **Open.Stream.StreamType** is DirectoryStream or **Open.Stream.Name** is empty:

        - **Open.Link.IsDeleted** MUST be set to TRUE.

    - Else:

        - **Open.Stream.IsDeleted** MUST be set to TRUE.

    - EndIf

- EndIf

- Phase 2 -Stream Deletion:

- If **Open.Stream.IsDeleted** is TRUE and **Open.File.OpenList** does not contain any Opens on **Open.Stream** (this is a close of the last Open to a stream that has been marked deleted), then:

    - **Open.Stream** MUST be removed from **Open.File.StreamList**.

    - If **Open**.**Stream**.**IsSparse** is TRUE, and there does not exist an *ExistingStream* in **Open.File.StreamList** such that *ExistingStream*.**IsSparse** is TRUE:

        - The object store MUST set **Open.File.FileAttributes.**FILE_ATTRIBUTE_SPARSE_FILE to FALSE, indicating that no streams of the file are sparse.

        - The object store MUST post a USN change as per section 3.1.4.11 with **File** equal to **File**, **Reason** equal to USN_REASON_STREAM_CHANGE | USN_REASON_BASIC_INFO_CHANGE, and **FileName** equal to **Open.Link.Name**.

    - Else:

- The object store MUST post a USN change as per section [3.1.4.11](#) with **File** equal to **File**, **Reason** equal to USN_REASON_STREAM_CHANGE, and **FileName** equal to **Open.Link.Name**.

- EndIf

- *StreamDeleted* MUST be set to TRUE.

- *PostUsnClose* MUST be set to TRUE.

- EndIf

- Phase 3 - File Deletion:

- If **Open.Link.IsDeleted** is TRUE and there does not exist an *ExistingOpen* in **Open.File.OpenList** that has *ExistingOpen*.**Link** equal to **Open.Link:**

  - Remove **Open.Link** from **Open.File.LinkList**.

  - Remove **Open.Link** from **Open.Link.ParentFile.DirectoryList**.

  - Set *LinkDeleted* to TRUE.

  - If **Open.File.LinkList** is empty:

    - Set *FileDeleted* to TRUE.

  - EndIf

- EndIf

- Phase 4 - Truncate on Close:

- Set *AllocationClusters* to ***ClustersFromBytes***(**Open**.**File**.**Volume**, **Open**.**Stream**.**AllocationSize**).

- Set *FileClusters* to ***ClustersFromBytes***(**Open**.**File**.**Volume**, **Open**.**Stream**.**FileSize**).

- If *AllocationClusters* > *FileClusters*:

  - This file has excess allocation. The object store SHOULD free (*AllocationClusters* - *FileClusters*) clusters of allocation from the end of the stream, and set **Open**.**Stream**.**AllocationSize** to *FileClusters* * **Open**.**File**.**Volume**.**ClusterSize**.

- EndIf

- Phase 5 -- Directory Change Notification:

- When a directory **Open** with outstanding directory change notification requests is closed, these requests are completed using the algorithm below.

- If **Open.Stream.StreamType** is DirectoryStream:

  - For each **ChangeNotifyEntry** in **Volume.ChangeNotifyList** where **ChangeNotifyEntry.OpenedDirectory** is equal to **Open** then the following actions MUST be taken:

    - Remove **ChangeNotifyEntry** from **Volume.ChangeNotifyList**.

- Complete the **ChangeNotify** operation with status STATUS_NOTIFY_CLEANUP.

    - EndFor

- EndIf

- If **Open.Link** is deleted, a directory change notification on **Open.Link.ParentFile** MUST be issued. Pseudocode for these notifications is as follows:

    - If *LinkDeleted* is TRUE:

        - Set *Action* to FILE_ACTION_REMOVED.

        - If **Open.Stream.StreamType** is DirectoryStream:

            - Set *FilterMatch* to FILE_NOTIFY_CHANGE_DIR_NAME.

        - Else:

            - Set *FilterMatch* to FILE_NOTIFY_CHANGE_FILE_NAME.

        - EndIf

        - Send directory change notification as per section 3.1.4.1 with **Volume** equal to **Open.File.Volume**, **Action** equal to *Action*, **FilterMatch** equal to *FilterMatch*, and **FileName** equal to **Open.FileName**.

    - EndIf

- If **Open.Stream** was deleted, then the stream deletion change notification MUST be issued. Pseudocode for this notification is as follows:

    - If *StreamDeleted* is TRUE:

        - Set *Action* to FILE_ACTION_REMOVED_STREAM.

        - Set *FilterMatch* to FILE_NOTIFY_CHANGE_STREAM_NAME.

        - Send directory change notification as per section 3.1.4.1 with **Volume** equal to **Open.File.Volume**, **Action** equal to *Action*, **FilterMatch** equal to *FilterMatch* and **FileName** equal to **Open.FileName**.

    - EndIf

- If **Open.File** has had other changes that were not notified, a directory change notification reflecting those changes MUST be issued. Pseudocode for this notification is as follows:

    - Set *FilterMatch* to **Open.File.PendingNotifications**.

    - If *FilterMatch* is nonzero:

        - Set *Action* to FILE_ACTION_MODIFIED.

        - Send directory change notification as per section 3.1.4.1 with **Volume** equal to **Open.File.Volume**, **Action** equal to *Action*, **FilterMatch** equal to *FilterMatch* and **FileName** equal to **Open.FileName**.

        - Set **Open.File.PendingNotifications** to zero.

- EndIf

- If this is an **Open** to a named data **Stream** (**Open.Stream.StreamType** is DataStream and **Open.Stream.Name** is not empty) and there have been changes to it that weren't previously notified, a directory change notification reflecting those changes must be issued. Pseudocode for this notification is as follows:

  - Set *FilterMatch* to **Open.Stream.PendingNotifications**.

  - If *FilterMatch* is nonzero:

    - Set *Action* to FILE_ACTION_MODIFIED_STREAM.

    - Send directory change notification as per section 3.1.4.1 with **Volume** equal to **Open.File.Volume**, **Action** equal to *Action*, **FilterMatch** equal to *FilterMatch* and **FileName** equal to **Open.FileName**.

    - Set **Open.Stream.PendingNotifications** to zero.

  - EndIf

  - If *LinkDeleted* is TRUE:

    - If *FileDeleted* is FALSE:

      - Post a USN change as per section 3.1.4.11 with **File** equal to **File**, **Reason** equal to USN_REASON_HARD_LINK_CHANGE, and **FileName** equal to **Open.Link.Name**.

      - Set *PostUsnClose* to TRUE.

    - Else:

      - Post a USN change as per section 3.1.4.11 with **File** equal to **File**, **Reason** equal to USN_REASON_FILE_DELETE | USN_REASON_CLOSE, and **FileName** equal to **Open.Link.Name**.

    - EndIf

  - EndIf

- Phase 6 -- USN Journal:

- If *PostUsnClose* is TRUE:

  - Post a USN change as per section 3.1.4.11 with **File** equal to **File**, **Reason** equal to USN_REASON_CLOSE, and **FileName** equal to **Open.Link.Name**.

- EndIf

- Phase 7 -- Tunnel Cache:

- If *LinkDeleted* is TRUE, then a new **TunnelCacheEntry** object *TunnelCacheEntry* MUST be constructed and added to the **Open.File.Volume.TunnelCacheList** as follows:

  - *TunnelCacheEntry*.**EntryTime** MUST be set to the current time.

  - *TunnelCacheEntry*.**ParentFile** MUST be set to **Open.Link.ParentFile**.

  - *TunnelCacheEntry*.**FileName** MUST be set to **Open.Link.Name**.

- *TunnelCacheEntry*.**FileShortName** MUST be set to **Open.Link.ShortName**.

- If **Open.FileName** matches **Open.Link.ShortName** then *TunnelCacheEntry*.**KeyByShortName** MUST be set to TRUE, else *TunnelCacheEntry*.**KeyByShortName** MUST be set to FALSE.

- *TunnelCacheEntry*.**FileCreationTime** MUST be set to **Open.File.CreationTime**.

- *TunnelCacheEntry*.**FileObjectId** MUST be set to **Open.File.ObjectId**.

- EndIf

- If **Open.File.FileType** is DirectoryFile and *LinkDeleted* is TRUE, then **Open.File** MUST have every *TunnelCacheEntry* associated with it invalidated:

  - For every *ExistingTunnelCacheEntry* in **Open.File.Volume.TunnelCacheList**:

    - If *ExistingTunnelCacheEntry*.**ParentFile** matches **Open.File**, then *ExistingTunnelCacheEntry* MUST be removed from **Open.File.Volume.TunnelCacheList**.

  - EndFor

- EndIf

- Phase 8 -- Oplock Cleanup:

- If **Open.Stream.Oplock** is not empty, the object store MUST check for an oplock break according to the algorithm in section 3.1.4.12, with input values as follows:

  - **Open** equal to this operation's **Open**

  - **Operation** equal to "CLOSE"

  - **OpParams** empty

- Phase 9 -- Byte Range Locks:

- All elements from **Open.Stream.ByteRangeLockList** where **ByteRangeLock.OwnerOpen** == **Open** MUST be removed.

- Phase 10 - Update Timestamps

- If *LinkDeleted* is TRUE and *FileDeleted* is FALSE and **Open.UserSetChangeTime** is FALSE:

  - Update **Open.File.LastChangeTime** to the current time.

- EndIf

- If **Open**.**GrantedAccess**.FILE_EXECUTE is TRUE and **Open.UserSetAccessTime** is FALSE:

  - Update **Open.File. LastAccessTime** to the current time.

- EndIf

- Upon successful completion of this operation, the object store MUST return:

  - **Status** set to STATUS_SUCCESS.

### 3.1.5.5   Server Requests Querying a Directory

The server provides:

- **Open:** An **Open** of a DirectoryStream.

- **FileInformationClass:** The type of information being queried, as specified in [MS-FSCC] section 2.4.

- **OutputBufferSize:** The maximum number of bytes to return in **OutputBuffer**.

- **RestartScan:** A Boolean which if TRUE, indicates enumeration should be restarted from the beginning of the directory. If FALSE enumeration should continue from the last position.

- **ReturnSingleEntry:** A Boolean which if TRUE indicates, at most one entry MUST be returned. If FALSE one or more entries MAY be returned up to what will fit in **OutputBufferSize** bytes.

- **FileIndex:** An index number from which to resume the enumeration if the object store supports it (optional).

- **FileNamePattern:** A Unicode string containing the file name pattern to match. The object store MUST treat any asterisk ("*") and question mark ("?") characters in **FileNamePattern** as wildcards. **FileNamePattern** MAY be empty, which the object store MUST treat as equivalent to the pattern "*".

On completion, the object store MUST return:

- **Status:** An NTSTATUS code that specifies the result.

- **OutputBuffer:** An array of bytes containing the query results. The structure of these bytes is dependent on the **FileInformationClass**, as noted in the relevant subsection.

- **ByteCount:** The number of bytes stored in **OutputBuffer**.

### 3.1.5.5.1   FileObjectIdInformation

The following local variable is used:

- Boolean value (initialized to FALSE): *EmptyPattern*

Support for this operation is optional. If the object store does not implement this functionality, the operation MUST be failed with STATUS_INVALID_DEVICE_REQUEST.

**OutputBuffer** is an array of one or more FILE_OBJECTID_INFORMATION structures as specified in [MS-FSCC] section 2.4.28.

This Information class can only be sent to a specific directory that maintains a list of all ObjectID's on the volume. The name of this directory is: "\$Extend\$ObjId:$O:$INDEX_ALLOCATION". If it is sent to any other file or directory on the volume, the operation MUST be failed with STATUS_INVALID_INFO_CLASS.<12>

Pseudocode for the operation is as follows:

- If **FileNamePattern** is not empty and **FileNamePattern.Length** (0 is a valid length) is not a multiple of 4, the operation MUST be failed with STATUS_INVALID_PARAMETER.

- If **FileNamePattern** is empty, the object store MUST set *EmptyPattern* to TRUE; otherwise it MUST set *EmptyPattern* to FALSE.

- If **FileNamePattern.Length** is less than the size of an ObjectId (16 bytes), **FileNamePattern.Buffer** will be zero filled up to the size of ObjectId.

- The object store MUST search the volume for *Files* having *File*.**ObjectId** matching **FileNamePattern.** To determine if there is a match, **FileNamePattern.Buffer** is compared to **ObjectId** in chunks of ULONG (4 bytes). Any comparison where the **ObjectId** chunk is greater than or equal to the **FileNamePattern.Buffer** chunk is considered a match. If **FileNamePattern.Length** is longer than the size of **ObjectId** and the first 16 bytes (size of **ObjectId**) of **FileNamePattern.Buffer** is identical to *ObjectId*, **FileNamePatter.Buffer** is considered as greater than **ObjectId**.<13>

- If **RestartScan** is FALSE and *EmptyPattern* is TRUE and there is no match, the operation MUST be failed with STATUS_NO_MORE_FILES.

- The operation MUST fail with STATUS_NO_SUCH_FILE under any of the following conditions:

  - *EmptyPattern* is FALSE and there is no match.

  - *EmptyPattern* is TRUE and **RestartScan** is TRUE and there is no match.

- The operation MUST fail with STATUS_BUFFER_OVERFLOW if **OutputBufferSize** < sizeof (FILE_OBJECTID_INFORMATION).

- If there is at least one match, the operation is considered successful. The object store MUST return:

  - **Status** set to STATUS_SUCCESS.

  - **OutputBuffer** containing an array of as many FILE_OBJECTID_INFORMATION structures that match the query as will fit in **OutputBuffer** unless **ReturnSingleEntry** is TRUE, in which case only a single entry will be stored in **OutputBuffer**. To continue the query, **FileNamePattern** MUST be empty and RestartScan MUST be FALSE.

  - **ByteCount** set to the number of bytes filled in **OutputBuffer**.

### 3.1.5.5.2   FileReparsePointInformation

The following local variable is used:

- Boolean value (initialized to FALSE): *EmptyPattern*

Support for this operation is optional. If the object store does not implement this functionality, the operation MUST be failed with STATUS_INVALID_DEVICE_REQUEST.

**OutputBuffer** is an array of one or more FILE_REPARSE_POINT_INFORMATION structures as specified in [MS-FSCC] section 2.4.35.

This Information class can only be sent to a specific directory that maintains a list of all Reparse Points on **Open.File.Volume**. The name of this directory is: "\$Extend\$Reparse:$R:$INDEX_ALLOCATION". If it is sent to any other file or directory on **Open.File.Volume**, the operation MUST be failed with STATUS_INVALID_INFO_CLASS.<14>

Pseudocode for the operation is as follows:

- If **FileNamePattern** is not empty and **FileNamePattern.Length** (0 is a valid length) is not a multiple of 4, the operation MUST be failed with STATUS_INVALID_PARAMETER.

- If **FileNamePattern** is empty, the object store MUST set *EmptyPattern* to TRUE; otherwise it MUST set *EmptyPattern* to FALSE.

- If **FileNamePattern.Length** is less than the size of a **ReparseTag** (4 bytes), **FileNamePattern.Buffer** will be zero filled up to the size of ReparseTag.

- If *EmptyPattern* is FALSE:

    - The object store MUST search **Open.File.Volume** for *Files* having *File* **ReparseTag** matching **FileNamePattern.**

- Else

    - The object store MUST match all reparse tags on the volume.

- EndIf

- If **RestartScan** is FALSE and *EmptyPattern* is TRUE and there is no match, the operation MUST be failed with STATUS_NO_MORE_FILES.

- The operation MUST fail with STATUS_NO_SUCH_FILE under any of the following conditions:

    - *EmptyPattern* is FALSE and there is no match.

    - *EmptyPattern* is TRUE and **RestartScan** is TRUE and there is no match.

- The operation MUST fail with STATUS_BUFFER_OVERFLOW if **OutputBuffer** is not large enough to hold the first matching entry.

- If there is at least one match, the operation is considered successful. The object store MUST return:

    - **Status** set to STATUS_SUCCESS.

    - **OutputBuffer** containing an array of as many FILE_REPARSE_POINT_INFORMATION structures that match the query as will fit in **OutputBuffer** unless **ReturnSingleEntry** is TRUE, in which case only a single entry will be stored in **OutputBuffer**. To continue the query, **FileNamePattern** MUST be empty and **RestartScan** MUST be FALSE.

    - **ByteCount** set to the number of bytes filled in **OutputBuffer**.

### 3.1.5.5.3 Directory Information Queries

This section describes how the object store processes directory queries for the following **FileInformationClass** values:

- FileBothDirectoryInformation

- FileDirectoryInformation

- FileFullDirectoryInformation

- FileIdBothDirectoryInformation

- FileIdFullDirectoryInformation

- FileNamesInformation

This algorithm uses the following local variables:

- Boolean value (initialized to FALSE): *FirstQuery*

- **Link**: *Link*

- **Stream**: *DefaultStream*

- 32-bit Unsigned integers: *FileNameBytesToCopy*, *BaseLength*, *FoundNameLength*

- Pointer to given **FileInformationClass** Structure: *Entry*, *LastEntry*

- Status (initialized to STATUS_SUCCESS): *StatusToReturn*

Pseudocode for the algorithm is as follows:

- If **OutputBufferSize** is less than the size needed to return a single entry, the operation MUST be failed with STATUS_INFO_LENGTH_MISMATCH. The below subsections describe the initial size checks for **OutputBufferSize** to determine whether any entries can be returned.

- If **Open.File** is not a **DirectoryFile**, the operation MUST be failed with STATUS_INVALID_PARAMETER.

- If **Open.QueryPattern** is empty:

  - If **FileNamePattern** is empty:

    - Set **FileNamePattern** to "*".

  - Else:

    - If **FileNamePattern** is not a valid filename component as described in [MS-FSCC] section 2.1.5, with the exceptions that wildcard characters described in section 3.1.4.3 are permitted and the strings "." and ".." are permitted, the operation MUST be failed with STATUS_OBJECT_NAME_INVALID.

  - EndIf

  - *FirstQuery* = TRUE

  - Set **Open.QueryPattern** to **FileNamePattern** for use in subsequent queries.

- Else:

  - *FirstQuery* = FALSE

- EndIf

- If **RestartScan** is TRUE or **Open.QueryLastEntry** is empty:

  - Set **Open.QueryLastEntry** to the first *Link* in **Open.File.DirectoryList**, thus enumerating the directory from its beginning.

- EndIf

- Set *Entry* and *LastEntry* to point to the front of **OutputBuffer**.

- Set **ByteCount** to zero.

- Set *BaseLength* to **FieldOffset(**FileInformationClass.FileName**)**. In other words save the size of the fixed length portion of the given Information Class.

- For each *Link* in **Open.File.DirectoryList** starting at **Open.QueryLastEntry**:

  - If **ReturnSingleEntry** is TRUE and *Entry* != **OutputBuffer**, then break.

  - If *FirstQuery* is TRUE, the object store MUST set the "." and ".." file names as the first two records returned unless one of the following is TRUE:

    - **Open.File** == **File.Volume.RootDirectory**

    - **FileNamePattern** == "."

    - **FileNamePattern** contains wildcard characters as described in section 3.1.4.3 and the Unicode string "." matches **FileNamePattern** according to the algorithm in section 3.1.4.4.

  - EndIf

  - If *Link*.**Name** or *Link*.**ShortName** matches **FileNamePattern** as described in section 3.1.4.4 using the following parameters: **FileName** set to *Link*.**Name** then *Link*.**ShortName** if not empty, **Expression** set to **FileNamePattern** and **Ignorecase** set to **Open.IsCaseInsensitive**, then:

    - Set *FoundNameLength* to the length, in bytes, of *Link*.Name.

    - If *Entry* != **OutputBuffer(**one or more structures have already been copied into **OutputBuffer)** and (**ByteCount** + *BaseLength* + *FoundNameLength*) > **OutputBufferSize** then break.

    - Set *DefaultStream* to the entry in *Link*.**File.StreamList** where *DefaultStream*.**Name** is empty (locate the default stream for the given file or directory).

    - The object store MUST copy the fixed portion of the given **FileInformationClass** structure to *Entry* as described in the subsections below. This does not include copying the **FileName** field.

    - If (**ByteCount** + *BaseLength* + *FoundNameLength*) > **OutputBufferSize** then:

      - Set *FileNameBytesToCopy* to **OutputBufferSize** - **ByteCount** - *BaseLength*.

      - Set *StatusToReturn* to STATUS_BUFFER_OVERFLOW.

      - The scenario where a partial filename is returned only occurs on the first record being returned. The earlier checks guarantee that there will be room for the fixed portion of the given **FileInformationClass** structure.

    - EndIf

    - Copy *FileNameBytesToCopy* bytes from *Link*.**Name** into **FileInformationClass.Filename** field.

    - Set *LastEntry*.**NextEntryOffset** to *Entry* - **OutputBuffer**.

    - Set **ByteCount** to **BlockAlign(ByteCount**, 8**)** + *BaseLength* + *FileNameBytesToCopy*.

    - If *StatusToReturn* != STATUS_SUCCESS, then break.

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- Set *LastEntry* to *Entry*.

- Set *Entry* to **OutputBuffer** + **ByteCount**, which points to the beginning of the next record to be returned (if any).

- EndIfSet **Open.QueryLastEntry** to *Link*.

- EndFor

- If no records are being returned:

  - If *FirstQuery* is TRUE:

    - Set *StatusToReturn* to STATUS_NO_SUCH_FILE, which means no files were found in this directory that match the given wildcard pattern.

  - Else:

    - Set *StatusToReturn* to STATUS_NO_MORE_FILES, which means no more files were found in this directory that match the given wildcard pattern.

- EndIf

- If **Open.File.UserSetAccessTime** is FALSE, the object store MUST update **Open.File.LastAccessTime** to the current system time.

- The object store MUST return:

  - **Status** set to *StatusToReturn*.

  - **OutputBuffer** containing an array of as many entries that match the query as will fit in **OutputBufferSize**.

  - **BytesReturned** containing the number of bytes filled in **OutputBuffer**.

### 3.1.5.5.3.1   FileBothDirectoryInformation

**OutputBuffer** is an array of one or more FILE_BOTH_DIR_INFORMATION structures as described in [MS-FSCC] section 2.4.8. *Entry* is a parameter to this routine that points to the current FILE_BOTH_DIR_INFORMATION structure to fill out. Note that the FileName field is not set in this section.

Pseudocode for the operation is as follows:

- If **OutputBufferSize** is smaller than **FieldOffset(**FILE_BOTH_DIR_INFORMATION.FileName**)**, the operation MUST be failed with STATUS_INFO_LENGTH_MISMATCH.

- The object store MUST process this query using the algorithm described in section 3.1.5.5.3.

- *Entry* MUST be filled out as follows:

  - *Entry*.**NextEntryOffset** set to zero

  - *Entry*.**FileIndex** set to zero

  - *Entry*.**CreationTime** set to *Link*.**File.CreationTime**

  - *Entry*.**LastAccessTime** set to *Link*.**File.LastAccessTime**

- *Entry*.**LastWriteTime** set to *Link*.**File.LastModificationTime**

- *Entry*.**ChangeTime** set to *Link*.**File.LastChangeTime**

- *Entry*.**EndOfFile** set to *DefaultStream*.**Size**

- *Entry*.**AllocationSize** set to *DefaultStream*.**AllocationSize**

- *Entry*.**FileAttributes** set to *Link*.**File.FileAttributes**

- If *Link*.**File.FileType** is DirectoryFile:

  - *Entry*.**FileAttributes.FILE_ATTRIBUTE_DIRECTORY** is set

- EndIf

- If *Entry*.**FileAttributes** has no attributes set:

  - *Entry*.**FileAttributes.FILE_ATTRIBUTE_NORMAL** is set

- EndIf

- If *Link*.**File.FileAttributes.FILE_ATTRIBUTE_REPARSE_POINT** is set:

  - *Entry*.**EaSize** set to *Link*.**File.ReparseTag**

- Else:

  - *Entry*.**EaSize** set to *Link*.**File.ExtendedAttributesLength**

- EndIf

- If *Link*.**ShortName** is not empty:

  - *Entry*.**ShortNameLength** set to the length, in bytes, of *Link*.**ShortName**

  - *Entry*.**ShortName** set to *Link*.**ShortName** padding with zeroes as necessary

- Else:

  - *Entry*.**ShortNameLength** set to zero

  - *Entry*.**ShortName** is filled with zeroes

- EndIf

- *Entry*.**FileNameLength** set to the length ,in bytes, of *Link*.**Name**

### 3.1.5.5.3.2   FileDirectoryInformation

**OutputBuffer** is an array of one or more FILE_DIRECTORY_INFORMATION structures as described in [MS-FSCC] section 2.4.10. *Entry* is a parameter to this routine that points to the current FILE_DIRECTORY_INFORMATION structure to fill out. Note that the FileName field is not set in this section.

Pseudocode for the operation is as follows:

- If **OutputBufferSize** is smaller than ***FieldOffset(***FILE_DIRECTORY_INFORMATION.FileName***)***, the operation MUST be failed with STATUS_INFO_LENGTH_MISMATCH.

- The object store MUST process this query using the algorithm described in section 3.1.5.5.3.

- *Entry* MUST be filled out as follows:

  - *Entry*.**NextEntryOffset** set to zero

  - *Entry*.**FileIndex** set to zero

  - *Entry*.**CreationTime** set to *Link*.**File.CreationTime**

  - *Entry*.**LastAccessTime** set to *Link*.**File.LastAccessTime**

  - *Entry*.**LastWriteTime** set to *Link*.**File.LastModificationTime**

  - *Entry*.**ChangeTime** set to *Link*.**File.LastChangeTime**

  - *Entry*.**EndOfFile** set to *DefaultStream*.**Size**

  - *Entry*.**AllocationSize** set to *DefaultStream*.**AllocationSize**

  - *Entry*.**FileAttributes** set to *Link*.**File.FileAttributes**

  - If *Link*.**File.FileType** is DirectoryFile:

    - *Entry*.**FileAttributes.FILE_ATTRIBUTE_DIRECTORY** is set

  - EndIf

  - If *Entry*.**FileAttributes** has no attributes set:

    - *Entry*.**FileAttributes.FILE_ATTRIBUTE_NORMAL** is set

  - EndIf

  - *Entry*.**FileNameLength** set to the length ,in bytes, of *Link*.**Name**

### 3.1.5.5.3.3   FileFullDirectoryInformation

**OutputBuffer** is an array of one or more FILE_FULL_DIR_INFORMATION structures as described in [MS-FSCC] section 2.4.14. *Entry* is a parameter to this routine that points to the current FILE_FULL_DIR_INFORMATION structure to fill out. Note that the FileName field is not set in this section.

Pseudocode for the operation is as follows:

- If **OutputBufferSize** is smaller than *FieldOffset(*FILE_FULL_DIR_INFORMATION.FileName*)*, the operation MUST be failed with STATUS_INFO_LENGTH_MISMATCH.

- The object store MUST process this query using the algorithm described in section 3.1.5.5.3.

- *Entry* MUST be filled out as follows:

  - *Entry*.**NextEntryOffset** set to zero

  - *Entry*.**FileIndex** set to zero

  - *Entry*.**CreationTime** set to *Link*.**File.CreationTime**

  - *Entry*.**LastAccessTime** set to *Link*.**File.LastAccessTime**

- *Entry*.**LastWriteTime** set to *Link*.**File.LastModificationTime**

- *Entry*.**ChangeTime** set to *Link*.**File.LastChangeTime**

- *Entry*.**EndOfFile** set to *DefaultStream*.**Size**

- *Entry*.**AllocationSize** set to *DefaultStream*.**AllocationSize**

- *Entry*.**FileAttributes** set to *Link*.**File.FileAttributes**

- If *Link*.**File.FileType** is DirectoryFile:

  - *Entry*.**FileAttributes.FILE_ATTRIBUTE_DIRECTORY** is set

- EndIf

- If *Entry*.**FileAttributes** has no attributes set:

  - *Entry*.**FileAttributes.FILE_ATTRIBUTE_NORMAL** is set

- EndIf

- If *Link*.**File.FileAttributes.FILE_ATTRIBUTE_REPARSE_POINT** is SET:

  - *Entry*.**EaSize** set to *Link*.**File.ReparseTag**

- Else:

  - *Entry*.**EaSize** set to *Link*.**File.ExtendedAttributesLength**

- EndIf

  - *Entry*.**FileNameLength** set to the length, in bytes, of *Link*.**Name**

### 3.1.5.5.3.4   FileIdBothDirectoryInformation

**OutputBuffer** is an array of one or more FILE_ID_BOTH_DIR_INFORMATION structures as described in [MS-FSCC] section 2.4.17. *Entry* is a parameter to this routine that points to the current FILE_ID_BOTH_DIR_INFORMATION structure to fill out. Note that the FileName field is not set in this section.

Pseudocode for the operation is as follows:

- If **OutputBufferSize** is smaller than
  **FieldOffset(**FILE_ID_BOTH_DIR_INFORMATION.FileName**)**, the operation MUST be failed with STATUS_INFO_LENGTH_MISMATCH.

- The object store MUST process this query using the algorithm described in section 3.1.5.5.3.

- *Entry* MUST be filled out as follows:

  - *Entry*.**NextEntryOffset** set to zero

  - *Entry*.**FileIndex** set to zero

  - *Entry*.**CreationTime** set to *Link*.**File.CreationTime**

  - *Entry*.**LastAccessTime** set to *Link*.**File.LastAccessTime**

- *Entry*.**LastWriteTime** set to *Link*.**File.LastModificationTime**

- *Entry*.**ChangeTime** set to *Link*.**File.LastChangeTime**

- *Entry*.**EndOfFile** set to *DefaultStream*.**Size**

- *Entry*.**AllocationSize** set to *DefaultStream*.**AllocationSize**

- *Entry*.**FileAttributes** set to *Link*.**File.FileAttributes**

- If *Link*.**File.FileType** is DirectoryFile:

  - *Entry*.**FileAttributes.FILE_ATTRIBUTE_DIRECTORY** is set

- EndIf

- If *Entry*.**FileAttributes** has no attributes set:

  - *Entry*.**FileAttributes.FILE_ATTRIBUTE_NORMAL** is set

- EndIf

- If *Link*.**File.FileAttributes.FILE_ATTRIBUTE_REPARSE_POINT** is SET:

  - *Entry*.**EaSize** set to *Link*.**File.ReparseTag**

- Else:

  - *Entry*.**EaSize** set to *Link*.**File.ExtendedAttributesLength**

- EndIf

- If *Link*.**ShortName** is not empty:

  - *Entry*.**ShortNameLength** set to the length, in bytes, of *Link*.**ShortName**

  - *Entry*.**ShortName** set to *Link*.**ShortName** padding with zeroes as necessary

- Else:

  - *Entry*.**ShortNameLength** set to zero

  - *Entry*.**ShortName** filled with zeroes

- EndIf

  - *Entry*.**FileID** set to *Link*.**File.FileID**

  - *Entry*.**FileNameLength** set to the length, in bytes, of *Link*.**Name**

### 3.1.5.5.3.5   FileIdFullDirectoryInformation

**OutputBuffer** is an array of one or more FILE_ID_FULL_DIR_INFORMATION structures as described in [MS-FSCC] section 2.4.18. *Entry* is a parameter to this routine that points to the current FILE_ID_FULL_DIR_INFORMATION structure to fill out. Note that the FileName field is not set in this section.

Pseudocode for the operation is as follows:

- If **OutputBufferSize** is smaller than ***FieldOffset(***FILE_ID_FULL_DIR_INFORMATION.FileName***)***, the operation MUST be failed with STATUS_INFO_LENGTH_MISMATCH.

- The object store MUST process this query using the algorithm described in section 3.1.5.5.3.

- *Entry* MUST be filled out as follows:

  - *Entry*.**NextEntryOffset** set to zero

  - *Entry*.**FileIndex** set to zero

  - *Entry*.**CreationTime** set to *Link*.**File.CreationTime**

  - *Entry*.**LastAccessTime** set to *Link*.**File.LastAccessTime**

  - *Entry*.**LastWriteTime** set to *Link*.**File.LastModificationTime**

  - *Entry*.**ChangeTime** set to *Link*.**File.LastChangeTime**

  - *Entry*.**EndOfFile** set to *DefaultStream*.**Size**

  - *Entry*.**AllocationSize** set to *DefaultStream*.**AllocationSize**

  - *Entry*.**FileAttributes** set to *Link*.**File.FileAttributes**

  - If *Link*.**File.FileType** is DirectoryFile:

    - *Entry*.**FileAttributes.FILE_ATTRIBUTE_DIRECTORY** is set

  - EndIf

  - If *Entry*.**FileAttributes** has no attributes set:

    - *Entry*.**FileAttributes.FILE_ATTRIBUTE_NORMAL** is set

  - EndIf

  - If *Link*.**File.FileAttributes.FILE_ATTRIBUTE_REPARSE_POINT** is SET:

    - *Entry*.**EaSize** set to *Link*.**File.ReparseTag**

  - Else:

    - *Entry*.**EaSize** set to *Link*.**File.ExtendedAttributesLength**

  - EndIf

  - *Entry*.**FileID** set to *Link*.**File.FileID**

  - *Entry*.**FileNameLength** set to the length, in bytes, of *Link*.**Name**

### 3.1.5.5.3.6   FileNamesInformation

**OutputBuffer** is an array of one or more FILE_NAMES_INFORMATION structures as described in [MS-FSCC] section 2.4.26. *Entry* is a parameter to this routine that points to the current FILE_NAMES_INFORMATION structure to fill out. Note that the FileName field is not set in this section.

Pseudocode for the operation is as follows:

- If **OutputBufferSize** is smaller than **FieldOffset(**FILE_NAMES_INFORMATION.FileName**)**, the operation MUST be failed with STATUS_INFO_LENGTH_MISMATCH.

- The object store MUST process this query using the algorithm described in section 3.1.5.5.3.

- *Entry* MUST be filled out as follows:

  - *Entry*.**NextEntryOffset** set to zero

  - *Entry*.**FileIndex** set to zero

  - *Entry*.**FileNameLength** set to the length, in bytes, of *Link*.**Name**

### 3.1.5.6   Server Requests Flushing Cached Data

The server provides:

- **Open:** An **Open** of a DataFile or DirectoryFile for which it is to flush cached data.

On completion, the object store MUST return:

- **Status:** An NTSTATUS code that specifies the result.

The object store MUST flush all persistent attributes for **Open.File** to stable storage. In addition:

- If **Open.File.Volume.IsReadOnly** is TRUE, the operation MUST be failed with STATUS_MEDIA_WRITE_PROTECTED.

- The operation MUST be failed with the status code returned from the underlying physical storage. The operation flushes all eligible objects; however, only the first failure encountered is returned.

- The operation ensures that the directory structure is persisted to stable storage.<15>

Pseudocode for the operation is as follows:

- If **Open.FileType** is DirectoryFile:

  - *CurrentDirectory* = **Open.DirectoryFile**

    - Flush *CurrentDirectory*

  - While *CurrentDirectory* != *CurrentDirectory*.**Volume.RootDirectory**:

    - Set *CurrentLink* to the head of *CurrentDirectory*.**LinkList**, which should be the only link because directories cannot have hard links.

    - *CurrentDirectory* = *CurrentLink*.**ParentFile**

      - Flush *CurrentDirectory*

  - EndWhile

- EndIf

- Flush all open objects on the volume.

- If **Open.File** is equal to **Open.File.Volume.RootDirectory**:

  - For each *OpenFile* in **Open.File.Volume.OpenFileList**:

- Flush *OpenFile*

  - EndFor

- EndIf

### 3.1.5.7  Server Requests a Byte-Range Lock

The server provides:

- **Open:** An **Open** of a DataStream.

- **FileOffset:** A 64-bit unsigned integer containing the starting offset, in bytes.

- **Length:** A 64-bit unsigned integer containing the length, in bytes. This value MAY be zero.

- **ExclusiveLock:** A Boolean indicating whether the range is to be locked exclusively (TRUE) or shared (FALSE).

- **FailImmediately:** A Boolean indicating whether the lock request is to fail (TRUE) if the range is locked by another open or if it is to wait until the lock can be acquired (FALSE).

On completion, the object store MUST return:

- **Status:** An NTSTATUS code that specifies the result

Pseudocode for the operation is as follows:

- [Validation]

- If **Open.Stream.StreamType** is DirectoryStream, return STATUS_INVALID_PARAMETER, as byte range locks are not permitted on directories.

- If (((**FileOffset** + **Length** - 1) < **FileOffset**) && **Length** != 0)

  - This means that the requested range contains one or more bytes with offsets beyond the maximum 64-bit unsigned integer. The operation MUST be failed with STATUS_INVALID_LOCK_RANGE.

- EndIf

- [Processing]

- The object store MUST check for byte range lock conflicts by using the algorithm described in section 3.1.4.10, with **ByteOffset** set to **FileOffset**, **Length** set to **Length**, **IsExclusive** set to **ExclusiveLock**, **LockIntent** set to TRUE, and **Open** set to **Open**. If a conflict is detected, then:

  - If **FailImmediately** is TRUE, the operation MUST be failed with STATUS_LOCK_NOT_GRANTED.

  - Else

    - Insert operation into **CancelableOperations.CancelableOperationList**.

    - Wait until there are no overlapping **ByteRangeLocks** or until the operation is canceled per section 3.1.5.19. Overlapping **ByteRangeLocks** can be removed from **ByteRangeLockList** in different ways:

- - The **ByteRangeLock** can be explicitly unlocked as described in section 3.1.5.8.

    - - The **ByteRangeLock.OwnerOpen** can be closed as described in section 3.1.5.4.

  - EndIf

- EndIf

- Initialize a new *ByteRangeLock*:

  - *ByteRangeLock*.**LockOffset** MUST be initialized to **FileOffset**.

  - *ByteRangeLock*.**LockLength** MUST be initialized to **Length**.

  - *ByteRangeLock*.**IsExclusive** MUST be initialized to **ExclusiveLock**.

  - *ByteRangeLock*.**OwnerOpen** MUST be initialized to **Open**.

- Insert *ByteRangeLock* into **Open.Stream.ByteRangeLockList**.

- Complete this operation with STATUS_SUCCESS.

### 3.1.5.8  Server Requests an Unlock of a Byte-Range

The server provides:

- **Open:** An **Open** of a DataStream.

- **FileOffset:** A 64-bit unsigned integer containing the starting offset, in bytes.

- **Length:** A 64-bit unsigned integer containing the length, in bytes.

On completion, the object store MUST return:

- **Status:** An NTSTATUS code that specifies the result.

Pseudocode for the operation is as follows:

- [Validation]

- If **Open.Stream.StreamType** is DirectoryStream, return STATUS_INVALID_PARAMETER, as byte range locks are not permitted on directories.

- If (((**FileOffset** + **Length** - 1) < **FileOffset**) && **Length** != 0)

  - This means that the requested range contains one or more bytes with offsets beyond the maximum 64-bit unsigned integer. The operation MUST be failed with STATUS_INVALID_LOCK_RANGE.

- EndIf

- [Processing]

- Initialize *LockToRemove* to NULL.

- For each *ByteRangeLock* in **Open.Stream.ByteRangeLockList**:

  - If ((*ByteRangeLock*.**LockOffset** == **FileOffset**) and (*ByteRangeLock*.**LockLength** == **Length**) and (*ByteRangeLock*.**OwnerOpen** == **Open**)) then:

- Set *LockToRemove* to *ByteRangeLock*.

  - If (*LockToRemove*.**ExclusiveLock** == TRUE) then break.

  - EndIf

- EndFor

- If *LockToRemove* is not NULL:

  - Remove *LockToRemove* from **Open.Stream.ByteRangeLockList**.

  - Complete this operation with STATUS_SUCCESS.

- Else:

  - Complete this operation with STATUS_RANGE_NOT_LOCKED.

- EndIf

### 3.1.5.9  Server Requests an FsControl Request

The following section describes various File System Control (FSCTLs) operations that are implemented by the Object Store. Not all of these operations are implemented by all file systems.

#### 3.1.5.9.1  FSCTL_CREATE_OR_GET_OBJECT_ID

The server provides:

- **Open:** An **Open** of a DataFile or DirectoryFile.

- **OutputBufferSize:** The maximum number of bytes to return in **OutputBuffer**.

On completion, the object store MUST return:

- **Status:** An NTSTATUS code that specifies the result.

- **OutputBuffer:** An array of bytes that will return a FILE_OBJECTID_BUFFER structure as specified in [MS-FSCC] section 2.1.3.

- **BytesReturned:** The number of bytes returned in **OutputBuffer**.

Support for this operation is optional. If the object store does not implement this functionality, the operation MUST be failed with STATUS_INVALID_DEVICE_REQUEST.<16>

Pseudocode for the operation is as follows:

- If **Open.File.Volume.IsObjectIDsSupported** is FALSE, the operation MUST be failed with STATUS_VOLUME_NOT_UPGRADED.

- If **OutputBufferSize** is less than *sizeof(*FILE_OBJECTID_BUFFER*)*, the operation MUST be failed with STATUS_INVALID_PARAMETER.

- If **Open.File.ObjectId** is empty:

  - If **Open.File.Volume.IsReadOnly**, the operation MUST be failed with STATUS_MEDIA_WRITE_PROTECTED.

- The object store MUST set **Open.File.ObjectId** to a newly generated ObjectId GUID that is unique on **Open.File.Volume**.<17>

- EndIf

- If a new **Open.File.ObjectId** was generated above or if **Open.File.BirthVolumeId** and **Open.File.BirthObjectId** are both empty:

  - If **Open.File.Volume.IsReadOnly**, the operation MUST be failed with STATUS_MEDIA_WRITE_PROTECTED.

  - If **Open.File.BirthVolumeId** is empty, the object store MUST set **Open.File.BirthVolumeId** to **Open.File.Volume.VolumeId**.

  - If **Open.File.BirthObjectId** is empty, the object store MUST set **Open.File.BirthObjectId** to **Open.File.ObjectId**.

  - The object store MUST post a USN change as per section 3.1.4.11 with **File** equal to **File**, **Reason** equal to USN_REASON_OBJECT_ID_CHANGE, and **FileName** equal to **Open.Link.Name**.

- EndIf

If a new **Open.File.ObjectId** was generated above, the object store MUST update **Open.File.LastChangeTime**.<18>

The object store MUST populate the fields of **OutputBuffer** as follows:

- **OutputBuffer.ObjectId** set to **Open.File.ObjectId**.

- **OutputBuffer.BirthVolumeId** set to **Open.File.BirthVolumeId**.

- **OutputBuffer.BirthObjectId** set to **Open.File.BirthObjectId**.

- **OutputBuffer.DomainId** set to empty.

Upon successful completion of the operation, the object store MUST return:

- **BytesReturned** set to **sizeof(**FILE_OBJECTID_BUFFER**)**.

- **Status** set to STATUS_SUCCESS.

### 3.1.5.9.2  FSCTL_DELETE_OBJECT_ID

The server provides:

- **Open:** An **Open** of a DataFile or DirectoryFile.

On completion, the object store MUST return:

- **Status:** An NTSTATUS code that specifies the result.

Support for this operation is optional. If the object store does not implement this functionality, the operation MUST be failed with STATUS_INVALID_DEVICE_REQUEST.<19>

Pseudocode for the operation is as follows:

- If **Open.File.Volume.IsObjectIDsSupported** is FALSE, the operation MUST be failed with STATUS_VOLUME_NOT_UPGRADED.

- If **Volume.IsReadOnly** is TRUE, the operation MUST be failed with STATUS_MEDIA_WRITE_PROTECTED.

- If **Open.File.ObjectId** is empty, the operation MUST be completed with STATUS_SUCCESS.

- Update **Open.File.LastChangeTime** to the current time.<20>

- Post a USN change as per section 3.1.4.11 with **File** equal to **File**, **Reason** equal to USN_REASON_OBJECT_ID_CHANGE, and **FileName** equal to **Open.Link.Name**.

- Set **Open.File.ObjectId** to empty.

- Upon successful completion of the operation, the object store MUST return:

  - **Status** set to STATUS_SUCCESS.

### 3.1.5.9.3   FSCTL_DELETE_REPARSE_POINT

The server provides:

- **Open:** An **Open** of a DataFile or DirectoryFile.

- **ReparseTag:** An identifier indicating the type of the reparse point to delete, as defined in [MS-FSCC] section 2.1.2.1.

- **ReparseGUID:** A GUID indicating the type of the reparse point to delete.

On completion, the object store MUST return:

- **Status:** An NTSTATUS code that specifies the result.

Support for this operation is optional. If the object store does not implement this functionality, the operation MUST be failed with STATUS_INVALID_DEVICE_REQUEST.<21>

Pseudocode for the operation is as follows:

- Phase 1 -- Verify the parameters.

- If (**Open.GrantedAccess** & (FILE_WRITE_DATA | FILE_WRITE_ATTRIBUTES)) == 0, the operation MUST be failed with STATUS_ACCESS_DENIED.

- If **Open.File.Volume.IsReadOnly** is TRUE, the operation MUST be failed with STATUS_MEDIA_WRITE_PROTECTED.

- If **Open.File.Volume.IsReparsePointsSupported** is FALSE, the operation MUST be failed with STATUS_VOLUME_NOT_UPGRADED.

- If the **ReparseTag** is either IO_REPARSE_TAG_RESERVED_ZERO or IO_REPARSE_TAG_RESERVED_ONE, the operation MUST be failed with STATUS_IO_REPARSE_TAG_INVALID. The reserved reparse tags are defined in [MS-FSCC] section 2.1.2.1.

- If **ReparseTag** is a non-Microsoft Reparse Tag, then the **ReparseGUID** MUST be a valid GUID; otherwise the operation MUST be failed with STATUS_IO_REPARSE_DATA_INVALID.

- Phase 2 -- Validate that the requested tag deletion type matches with the stored tag type.

- If (**ReparseTag** != **Open.File.ReparseTag**), the operation MUST be failed with STATUS_IO_REPARSE_TAG_MISMATCH.

- If (**ReparseTag** is a non-Microsoft Reparse Tag && **Open.File.ReparseGUID** != **ReparseGUID**), the operation MUST be failed with STATUS_REPARSE_ATTRIBUTE_CONFLICT.

- Phase 3 -- Remove the reparse point from the File.

- Set **Open.File.ReparseData**, **Open.File.ReparseGUID**, and **Open.File.ReparseTag** to empty.

- Update **Open.File.LastChangeTime** to the current system time.<22>

- Set **Open.File.FileAttributes**.FILE_ATTRIBUTE_ARCHIVE to TRUE.

- Set **Open.File.PendingNotifications**.FILE_NOTIFY_CHANGE_LAST_ACCESS to TRUE.

- Upon successful completion of the operation, the object store MUST return:

  - **Status** set to STATUS_SUCCESS.

## 3.1.5.9.4 FSCTL_FILESYSTEM_GET_STATISTICS

The server provides**:**

- **Open:** An Open of a DataFile or DirectoryFile.

- **OutputBufferSize:** The maximum number of bytes to return in **OutputBuffer**.

On completion, the object store MUST return:

- **Status:** An NTSTATUS code that specifies the result.

- **OutputBuffer:** An array of bytes that will return an array of statistical data, one entry per host processor.

- **BytesReturned:** The number of bytes returned in **OutputBuffer**.

Support for this operation is optional. If the object store does not implement this functionality, the operation MUST be failed with STATUS_INVALID_DEVICE_REQUEST.<23>

Pseudocode for the operation is as follows:

- If **OutputBufferSize** is less than the total size of statistics information, then only **OutputBufferSize** bytes will be returned, and the operation MUST succeed but return with STATUS_BUFFER_OVERFLOW.

- Add each entry in the OutputBuffer as follows :

  - FILESYSTEM_STATISTICS structure as specified in [MS-FSCC] section 2.3.8.1.

  - An optional file system-specific structure as specified in [MS-FSCC] section 2.3.8.2.<24>

  - Padding bytes of zeros to bring total size of each entry to be a multiple of 64 bytes.

Upon successful completion of the operation, the object store MUST return:

- **BytesReturned** set to the number of total number of bytes of statistical information returned.

- **Status** set to STATUS_SUCCESS or STATUS_BUFFER_OVERFLOW.

### 3.1.5.9.5   FSCTL_FIND_FILES_BY_SID

The server provides:

- **Open:** An **Open** of a DirectoryStream.

- **FindBySidData:** An array of bytes containing a FIND_BY_SID_DATA structure as described in [MS-FSCC] section 2.3.9.

- **OutputBufferSize:** The maximum number of bytes to return in **OutputBuffer**.

On completion, the object store MUST return:

- **Status:** An NTSTATUS code that specifies the result.

- **OutputBuffer:** An array of bytes that will contain a 4-byte aligned array of FILE_NAME_INFORMATION structures as described in [MS-FSCC] section 2.3.10.

- **BytesReturned:** The number of bytes written to **OutputBuffer**

This operation also uses the following local variables:

- 32-bit unsigned integers (initialized to zero): *OutputBufferOffset*, *NameLength*

Support for this operation is optional. If the object store does not implement this functionality, the operation MUST be failed with STATUS_INVALID_DEVICE_REQUEST.<25>

Pseudocode for the operation is as follows:

- If **Open.Stream.StreamType** is DataStream, the operation MUST be failed with STATUS_INVALID_PARAMETER.

- If **Open.HasManageVolumeAccess** is FALSE and **Open.HasBackupAccess** is FALSE, the operation MUST be failed with STATUS_ACCESS_DENIED.

- If **Open.File.Volume.QuotaInformation** is empty, the operation MUST be failed with STATUS_NO_QUOTAS_FOR_ACCOUNT.

- If **OutputBufferSize** is less than *sizeof(*FILE_NAME_INFORMATION*)*, the operation MUST be failed with STATUS_INVALID_USER_BUFFER.

- If **FindBySidData.Restart** is TRUE, **Open.FindBySidRestartIndex** MUST be set to 0.

- For each **Link** in **Open.File.DirectoryList**, starting at **Open.FindBySidRestartIndex**:

  - If **Link.File.SecurityDescriptor.OwnerSid** is equal to **FindBySidData.SID**:

    - Set *NameLength* to the length of **Link.Name**, in bytes.

    - If (**OutputBufferLength -** *OutputBufferOffset*) is less than **BlockAlign**(*NameLength* **+ 6, 8**):

      - **BytesReturned** is set to *OutputBufferOffset*.

      - If *OutputBufferOffset* is not 0:

        - The operation returns with STATUS_SUCCESS.

- Else:

  - The operation MUST be failed with STATUS_BUFFER_TOO_SMALL.

  - EndIf

- EndIf

- Set **OutputBuffer**[*OutputBufferOffset*].**FileNameLength** to *NameLength*.

- Copy **Link.Name** to **OutputBuffer**[*OutputBufferOffset*].**Filename**.

- *OutputBufferOffset* = *OutputBufferOffset* + **BlockAlign**(*NameLength* **+ 6, 8**).

- EndIf

- Increment Open.FindBySidRestartIndex.

- EndFor

- Upon successful completion of the operation, the object store MUST return:

  - **BytesReturned** set to *OutputBufferOffset*.

  - **Status** set to STATUS_SUCCESS.

### 3.1.5.9.6   FSCTL_GET_COMPRESSION

The server provides:

- **Open:** An **Open** of a DataStream or DirectoryStream.

- **OutputBufferSize:** The maximum number of bytes to return in **OutputBuffer**.

On completion, the object store MUST return:

- **Status:** An NTSTATUS code that specifies the result.

- **OutputBuffer:** An array of bytes that will return a USHORT value representing the compression state of the stream, as specified in [MS-FSCC] section 2.3.12.

- **BytesReturned:** The number of bytes returned in **OutputBuffer**.

Support for this operation is optional. If the object store does not implement this functionality, the operation MUST be failed with STATUS_INVALID_DEVICE_REQUEST.<26>

Pseudocode for the operation is as follows:

- If **OutputBufferSize** is less than *sizeof(*USHORT*)* (2 bytes), the operation MUST be failed with STATUS_INVALID_PARAMETER.

- If **Open.Stream.DirectoryStream** is DirectoryStream:

  - If **Open.File.FileAttributes**.FILE_ATTRIBUTE_COMPRESSED is TRUE:

    - The object store MUST set **OutputBuffer.CompressionState** to COMPRESSION_FORMAT_LZNT1.

  - Else:

- The object store MUST set **OutputBuffer.CompressionState** to COMPRESSION_FORMAT_NONE.

- EndIf

- Else:

    - If **Open.Stream.IsCompressed** is TRUE:

        - The object store MUST set **OutputBuffer.CompressionState** to COMPRESSION_FORMAT_LZNT1.

    - Else:

        - The object store MUST set **OutputBuffer.CompressionState** to COMPRESSION_FORMAT_NONE.

    - EndIf

- EndIf

- Upon successful completion of the operation, the object store MUST return:

    - **BytesReturned** set to *sizeof(*USHORT*)* (2 bytes).

    - **Status** set to STATUS_SUCCESS.

### 3.1.5.9.7   FSCTL_GET_NTFS_VOLUME_DATA

The server provides:

- **Open:** An **Open** of a DataFile or DirectoryFile.

- **OutputBufferSize:** The maximum number of bytes to return in **OutputBuffer**.

On completion, the object store MUST return:

- **Status:** An NTSTATUS code that specifies the result.

- **OutputBuffer:** An array of bytes that will return a NTFS_VOLUME_DATA_BUFFER structure as specified in [MS-FSCC] section 2.3.14.

- **BytesReturned:** The number of bytes returned in **OutputBuffer**.

Support for this operation is optional. If the object store does not implement this functionality, the operation MUST be failed with STATUS_INVALID_DEVICE_REQUEST.<27>

Pseudocode for the operation is as follows:

- If **OutputBufferSize** is less than *sizeof(*NTFS_VOLUME_DATA_BUFFER*)*, the operation MUST be failed with STATUS_BUFFER_TOO_SMALL.

- The object store MUST populate the fields of **OutputBuffer** as follows:<28>

    - **OutputBuffer.VolumeSerialNumber** set to **Open.File.Volume.VolumeSerialNumber**.

    - **OutputBuffer.NumberSectors** set to **Open.File.Volume.TotalSpace / Open.File.Volume.SectorSize**.

- OutputBuffer.TotalClusters set to **Open.File.Volume.TotalSpace /
  Open.File.Volume.ClusterSize**.

- OutputBuffer.FreeClusters set to **Open.File.Volume.FreeSpace /
  Open.File.Volume.ClusterSize**.

- **OutputBuffer.TotalReserved** set to an implementation-specific value.

- **OutputBuffer.BytesPerSector** set to **Open.File.Volume.SectorSize**.

- **OutputBuffer.BytesPerCluster** set to **Open.File.Volume.ClusterSize**.

- **OutputBuffer.BytesPerFileRecordSegment** set to an implementation-specific value.

- **OutputBuffer.ClustersPerFileRecordSegment** set to an implementation-specific value.

- **OutputBuffer.MftValidDataLength** set to an implementation-specific value.

- **OutputBuffer.MftStartLcn** set to an implementation-specific value.

- **OutputBuffer.Mft2StartLcn** set to an implementation-specific value.

- **OutputBuffer.MftZoneStart** set to an implementation-specific value.

- **OutputBuffer.MftZoneEnd** set to an implementation-specific value.

- Upon successful completion of the operation, the object store MUST return:

  - **BytesReturned** set to *sizeof(*NTFS_VOLUME_DATA_BUFFER*)*.

  - **Status** set to STATUS_SUCCESS.

### 3.1.5.9.8   FSCTL_GET_OBJECT_ID

The server provides:

- **Open:** An **Open** of a DataFile or DirectoryFile.

- **OutputBufferSize:** The maximum number of bytes to return in **OutputBuffer**.

On completion, the object store MUST return:

- **Status:** An NTSTATUS code that specifies the result.

- **OutputBuffer:** An array of bytes that will return a FILE_OBJECTID_BUFFER structure as
  specified in [MS-FSCC] section 2.1.3.

- **BytesReturned:** The number of bytes returned in **OutputBuffer**.

Support for this operation is optional. If the object store does not implement this functionality, the
operation MUST be failed with STATUS_INVALID_DEVICE_REQUEST.<29>

Pseudocode for the operation is as follows:

- If **Open.File.Volume.IsObjectIDsSupported** is FALSE, the operation MUST be failed with
  STATUS_VOLUME_NOT_UPGRADED.

- If **OutputBufferSize** is less than *sizeof(*FILE_OBJECTID_BUFFER*)*, the operation MUST be failed
  with STATUS_INVALID_PARAMETER.

- If **Open.File.ObjectId** is empty, the operation MUST be failed with STATUS_OBJECTID_NOT_FOUND.

- The object store MUST populate the fields of **OutputBuffer** as follows:

  - **OutputBuffer.ObjectId** set to **Open.File.ObjectId**.

  - **OutputBuffer.BirthVolumeId** set to **Open.File.BirthVolumeId**.

  - **OutputBuffer.BirthObjectId** set to **Open.File.BirthObjectId**.

  - **OutputBuffer.DomainId** set to empty.

- Upon successful completion of the operation, the object store MUST return:

  - **BytesReturned** set to *sizeof (*FILE_OBJECTID_BUFFER*)*.

  - **Status** set to STATUS_SUCCESS.

### 3.1.5.9.9   FSCTL_GET_REPARSE_POINT

The server provides:

- **Open:** An **Open** of a DataFile or DirectoryFile.

- **OutputBufferSize:** The maximum number of bytes to return in **OutputBuffer**.

On completion, the object store **MUST** return:

- **OutputBuffer:** An array of bytes containing a REPARSE_DATA_BUFFER or REPARSE_GUID_DATA_BUFFER structure as defined in [MS-FSCC] sections 2.1.2.2 and 2.1.2.3, respectively.

- **BytesReturned:** The number of bytes returned to the caller.

- **Status:** An NTSTATUS code that specifies the result.

Support for this operation is optional. If the object store does not implement this functionality, the operation MUST be failed with STATUS_INVALID_DEVICE_REQUEST.<30>

Pseudocode for the operation is as follows:

- If **Open.File.Volume.IsReparsePointsSupported** is FALSE, the operation MUST be failed with STATUS_VOLUME_NOT_UPGRADED.

- Phase 1 -- Check whether there is a reparse point on the **File**

- If **Open.File.ReparseTag** is empty, the operation MUST be failed with STATUS_NOT_A_REPARSE_POINT.

- Phase 2 -- Verify that **OutputBufferSize** is large enough to contain the reparse point data header.

- If **Open.File.ReparseTag** is a Microsoft reparse tag as defined in [MS-FSCC] section 2.1.2.1, then **OutputBufferSize** MUST be >= *sizeof(*REPARSE_DATA_BUFFER*)*. If not, the operation MUST be failed with STATUS_BUFFER_TOO_SMALL.

- If **Open.File.ReparseTag** is a non-Microsoft reparse tag, then **OutputBufferSize** MUST be >= **sizeof(**REPARSE_GUID_DATA_BUFFER**)**. If it is not, the operation MUST be failed with STATUS_BUFFER TOO_SMALL.

- Phase 3 -- Return the reparse data

- Set **OutputBuffer.ReparseTag** to **Open.File.ReparseTag**.

- Set **OutputBuffer.ReparseDataLength** to the size of **Open.File.ReparseData**, in bytes.

- Set **OutputBuffer.Reserved** to zero.

- Copy as much of **Open.File.ReparseData** as can fit into the remainder of **OutputBuffer** starting at **OutputBuffer.DataBuffer**.

- If **Open.File.ReparseTag** is a non-Microsoft reparse tag, set **OutputBuffer.ReparseGUID** to **Open.File.ReparseGUID**.

- Upon successful completion of the operation, the object store MUST return:

    - **BytesReturned** set to the number of bytes written to **OutputBuffer**.

    - **Status** set to STATUS_SUCCESS.

### 3.1.5.9.10  FSCTL_GET_RETRIEVAL_POINTERS

The server provides:

- **Open:** An **Open** of a DataStream or DirectoryStream.

- **StartingVcnBuffer:** An array of bytes containing a STARTING_VCN_INPUT_BUFFER as described in [MS-FSCC] section 2.3.19.

- **OutputBufferSize:** The maximum number of bytes to return in **OutputBuffer**.

On completion, the object store MUST return:

- **OutputBuffer:** An array of bytes that will return a RETRIEVAL_POINTERS_BUFFER as defined in [MS-FSCC] section 2.3.20.

- **BytesReturned:** The number of bytes returned to the caller.

- **Status:** An NTSTATUS code that specifies the result.

Pseudocode for the operation is as follows:

- Phase 1 -- Verify Parameters

- If the size of **StartingVcnBuffer** is less than **sizeof** (STARTING_VCN_INPUT_BUFFER), the operation MUST be failed with STATUS_INVALID_PARAMETER.

- If **OutputBufferSize** is smaller than **sizeof(**RETRIEVAL_POINTERS_BUFFER**)**, the operation MUST be failed with STATUS_BUFFER_TOO_SMALL.

- If **StartingVcnBuffer.StartingVcn** is negative, the operation MUST be failed with STATUS_INVALID_PARAMETER.

- If **StartingVcnBuffer.StartingVcn** is greater than or equal to **Open.Stream.AllocationSize** divided by **Open.File.Volume.ClusterSize**, the operation MUST be failed with STATUS_END_OF_FILE.

- Phase 2 -- Locate and copy the extents into **OutputBuffer**.

- Find the first *Extent* in **Open.Stream.ExtentList** where *Extent*.**NextVcn** is greater than **StartingVcnBuffer.StartingVcn**.

- Set **OutputBuffer.StartingVcn** to the previous element's **NextVcn**. If the element is the first one in **Open.Stream.ExtentList**, set **OutputBuffer.StartVcn** to zero.

- Copy as many EXTENTS elements from **Open.Stream.ExtentList** starting with *Extent* as will fit into the remaining space in **OutputBuffer**, at offset **OutputBuffer.Extents**.

- Set **OutputBuffer.ExtentCount** to the number of EXTENTS elements copied.

- If not all of the elements in **Open.Stream.ExtentList** were copied into **OutputBuffer.Extents**, the operation MUST return STATUS_BUFFER_OVERFLOW.

- Upon successful completion of the operation, the object store MUST return:

  - **BytesReturned** set to the number of bytes written to **OutputBuffer**.

  - **Status** set to STATUS_SUCCESS or STATUS_BUFFER_OVERFLOW.

### 3.1.5.9.11 FSCTL_IS_PATHNAME_VALID

This operation always returns STATUS_SUCCESS.

### 3.1.5.9.12 FSCTL_LMR_GET_LINK_TRACKING_INFORMATION

This operation MUST be failed with STATUS_INVALID_DEVICE_REQUEST.

### 3.1.5.9.13 FSCTL_LMR_SET_LINK_TRACKING_INFORMATION

This operation MUST be failed with STATUS_INVALID_DEVICE_REQUEST.

### 3.1.5.9.14 FSCTL_QUERY_FAT_BPB

Support for this operation is optional. If this operation is not supported, this operation MUST be failed with STATUS_INVALID_DEVICE_REQUEST.<31>

The server provides:

- **Open:** An **Open** of a DataFile or DirectoryFile.

- **OutputBufferSize:** The maximum number of bytes to return in **OutputBuffer**.

On completion, the object store MUST return:

- **Status:** An NTSTATUS code that specifies the result.

- **OutputBuffer:** An array of bytes that will return the first 0x24 bytes of sector zero, on a FAT volume.

- **BytesReturned:** The number of bytes returned in **OutputBuffer**.

Support for this operation is optional. If the object store does not implement this functionality, the operation MUST be failed with STATUS_INVALID_DEVICE_REQUEST.<32>

Pseudocode for the operation is as follows:

- If **OutputBufferSize** is less than 0x24, the operation MUST be failed with STATUS_BUFFER_TOO_SMALL.

- The operation will now copy the first 0x24 bytes of sector 0 of the storage device associated with **Open.File.Volume** into **OutputBuffer**.

- Upon successful completion of the operation, the object store MUST return:

  - **BytesReturned** set to 0x24.

  - **Status** set to STATUS_SUCCESS.

### 3.1.5.9.15   FSCTL_QUERY_ALLOCATED_RANGES

The server provides:

- **Open:** An **Open** of a DataFile.

- **InputBuffer:** An array of bytes containing a single FILE_ALLOCATED_RANGE_BUFFER structure indicating the range to query for allocation, as specified in [MS-FSCC] section 2.3.32.

- **InputBufferSize:** The number of bytes in **InputBuffer**.

- **OutputBufferSize:** The maximum number of bytes to return in **OutputBuffer**.

On completion, the object store MUST return:

- **Status:** An NTSTATUS code that specifies the result.

- **OutputBuffer:** An array of bytes that will return an array of zero or more FILE_ALLOCATED_RANGE_BUFFER structures as specified in [MS-FSCC] section 2.3.32.

- **BytesReturned:** The number of bytes returned in **OutputBuffer**.

This operation uses the following local variables:

- 32-bit unsigned integer indicating the index of the next FILE_ALLOCATED_RANGE_BUFFER to fill in **OutputBuffer** (initialized to 0): *OutputBufferIndex*.

- 64-bit unsigned integer *QueryStart:* Is initialized to **ClustersFromBytesTruncate**(**Open**.**File**.**Volume**, **InputBuffer**.**FileOffset**). This is the cluster containing the first byte of the queried range.

- 64-bit unsigned integer *QueryNext:* Is initialized to **ClustersFromBytesTruncate**(**Open**.**File**.**Volume**, (**InputBuffer**.**FileOffset** + **InputBuffer**.**Length** - 1) ) + 1. This is the cluster following the last cluster of the range.

- 64-bit unsigned integers (initialized to 0): *ExtentFirstVcn*, *ExtentNextVcn*, *RangeFirstVcn*, *RangeNextVcn*

- Boolean values (initialized to FALSE): *FoundRangeStart*, *FoundRangeEnd*

- Pointer to an EXTENTS element (initialized to NULL): *Extent*

- FILE_ALLOCATED_RANGE_BUFFER (initialized to zeros): *Range*

Support for this operation is optional. If the object store does not implement this functionality, the operation MUST be failed with STATUS_INVALID_DEVICE_REQUEST.<33>

Pseudocode for the operation is as follows:

- If **Open**.**Stream**.**StreamType** is DirectoryStream, the operation MUST be failed with STATUS_INVALID_PARAMETER.

- If **InputBufferSize** is less than *sizeof(*FILE_ALLOCATED_RANGE_BUFFER*)*, the operation MUST be failed with STATUS_INVALID_PARAMETER.

- If (**InputBuffer**.**FileOffset** < 0) or (**InputBuffer**.**Length** < 0) or (**InputBuffer**.**Length** > MAXLONGLONG - **InputBuffer**.**FileOffset**), the operation MUST be failed with STATUS_INVALID_PARAMETER. If **InputBuffer**.**Length** is 0:

  - Set **BytesReturned** to 0.

  - Return STATUS_SUCCESS.

- EndIf

- If **OutputBufferSize** < *sizeof(*FILE_ALLOCATED_RANGE_BUFFER*)*, the operation MUST be failed with STATUS_BUFFER_TOO_SMALL.

- If **Open**.**Stream**.**IsSparse** is FALSE:

  - Set **OutputBuffer**.**FileOffset** to **InputBuffer**.**FileOffset**.

  - Set **OutputBuffer**.**Length** to **InputBuffer**.**Length**.

  - Set **BytesReturned** to *sizeof(*FILE_ALLOCATED_RANGE_BUFFER*)*.

  - Return STATUS_SUCCESS.

- Else:

  - For sparse files, return a list of contiguous allocated ranges within the requested range. Contiguous allocated ranges in a sparse file might be fragmented on disk, therefore it is necessary to loop through the EXTENTS on this stream, coalescing the adjacent allocated EXTENTS into a single FILE_ALLOCATED_RANGE_BUFFER entry.

  - Set **Status** to STATUS_SUCCESS.

  - Set **BytesReturned** to 0.

  - For each *Extent* in **Open**.**Stream**.**ExtentList**:

    - Set *ExtentFirstVcn* to *ExtentNextVcn*.

    - Set *ExtentNextVcn* to *Extent*.**NextVcn**.

    - If *Extent*.**Lcn** != 0xffffffffffffffff, meaning *Extent* is allocated (not a sparse hole):

      - If *FoundRangeStart* is FALSE:

        - If *QueryStart* < *ExtentFirstVcn*:

- Set *FoundRangeStart* to TRUE.

- Set *RangeFirstVcn* to *ExtentFirstVcn*.

- Else If *ExtentFirstVcn <= QueryStart* and *QueryStart < ExtentNextVcn*:

  - Set *FoundRangeStart* to TRUE.

  - Set *RangeFirstVcn* to *QueryStart*.

- EndIf

- EndIf

- If *FoundRangeStart* is TRUE:

  - If *QueryNext <= ExtentFirstVcn*:

    - Break out of the For loop.

  - Else If *ExtentFirstVcn < QueryNext* and *QueryNext <= ExtentNextVcn*:

    - Set *FoundRangeEnd* to TRUE.

    - Set *RangeNextVcn* to *QueryNext*.

  - Else (*ExtentNextVcn < QueryNext*):

    - Set *FoundRangeEnd* to FALSE.

    - Set *RangeNextVcn* to *ExtentNextVcn*.

  - EndIf

- EndIf

- Else If *FoundRangeStart* is TRUE:

  - Set *FoundRangeEnd* to TRUE.

- EndIf

- If *FoundRangeEnd* is TRUE:

  - Set *FoundRangeStart* to FALSE and *FoundRangeEnd* to FALSE.

  - Add *Range* to *OutputBuffer* as follows:

    - Set *Range*.**FileOffset** to *RangeFirstVcn* * **Open**.**File**.**Volume**.**ClusterSize**.

    - Set *Range*.**Length** to (*RangeNextVcn* - *RangeFirstVcn*) * **Open**.**File**.**Volume**.**ClusterSize**.

    - If **OutputBufferSize** < ((*OutputBufferIndex* + 1) * *sizeof(*FILE_ALLOCATED_RANGE_BUFFER*)* ) then:

      - Set *RangeFirstVcn* to 0 and *RangeNextVcn* to 0.

      - Set **Status** to STATUS_BUFFER_OVERFLOW.

- ▪ Break out of the For loop.

- ▪ EndIf

- ▪ Copy *Range* to **OutputBuffer**[*OutputBufferIndex*].

- ▪ Increment *OutputBufferIndex* by 1.

- ▪ Set *RangeFirstVcn* to 0 and *RangeNextVcn* to 0.

- ▪ EndIf

- ▪ EndFor

- ▪ If *RangeNextVcn* is not 0:

  - ▪ If **OutputBufferSize** < ((*OutputBufferIndex* + 1) * ***sizeof(***FILE_ALLOCATED_RANGE_BUFFER***)***) then:

    - ▪ Set **Status** to STATUS_BUFFER_OVERFLOW.

  - ▪ Else add *Range* to *OutputBuffer* as follows:

    - ▪ Set *Range*.**FileOffset** to *RangeFirstVcn* * **Open.File.Volume.ClusterSize**.

    - ▪ Set *Range*.**Length** to (*RangeNextVcn* - *RangeFirstVcn*) * **Open.File.Volume.ClusterSize**.

    - ▪ Copy *Range* to **OutputBuffer**[*OutputBufferIndex*].

    - ▪ Increment *OutputBufferIndex* by 1.

  - ▪ EndIf

- ▪ EndIf

- ▪ Bias the first and the last returned ranges so that they match the offset/length passed in, using the following algorithm:

- ▪ If *OutputBufferIndex* > 0:

  - ▪ If **OutputBuffer**[0].**FileOffset** < **InputBuffer.FileOffset**:

    - ▪ Set **OutputBuffer**[0].**Length** to **OutputBuffer**[0].**Length** - (**InputBuffer.FileOffset** - **OutputBuffer**[0].**FileOffset**).

    - ▪ Set **OutputBuffer**[0].**FileOffset** to **InputBuffer.FileOffset**.

  - ▪ EndIf

  - ▪ If (**OutputBuffer**[*OutputBufferIndex* - 1].**FileOffset** + **OutputBuffer**[*OutputBufferIndex* - 1].**Length**) > (**InputBuffer**.**FileOffset** + **InputBuffer**.**Length**):

    - ▪ Set **OutputBuffer**[*OutputBufferIndex* - 1].**Length** to **InputBuffer.FileOffset** + **InputBuffer.Length** - **OutputBuffer**[*OutputBufferIndex* - 1].**FileOffset**.

  - ▪ EndIf

- ▪ EndIf

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- Endif

- Upon successful completion of the operation, the object store MUST return:

    - **BytesReturned** set to *OutputBufferIndex* * *sizeof(*FILE_ALLOCATED_RANGE_BUFFER*)*.

    - **Status** set to STATUS_SUCCESS.

### 3.1.5.9.16   FSCTL_QUERY_ON_DISK_VOLUME_INFO

The server provides:

- **Open:** An **Open** of a DataFile.

- **OutputBufferSize:** The maximum number of bytes to return in **OutputBuffer**.

On completion, the object store MUST return:

- **Status:** An NTSTATUS code that specifies the result.

- **OutputBuffer:** An array of bytes that will return a FILE_QUERY_ON_DISK_VOL_INFO_BUFFER as defined in [MS-FSCC] section 2.3.36.

- **BytesReturned:** The number of bytes returned in **OutputBuffer**.

Support for this operation is optional. If the object store does not implement this functionality, the operation MUST be failed with STATUS_INVALID_DEVICE_REQUEST.<34>

Pseudocode for the operation is as follows:

- If **OutputBufferSize** is less than *sizeof(*FILE_QUERY_ON_DISK_VOL_INFO_BUFFER*)*, the operation MUST be failed with STATUS_BUFFER_TOO_SMALL.

- The object store MUST populate the fields of **OutputBuffer** as follows:

    - **OutputBuffer.DirectoryCount** set to **Open.File.Volume.DirectoryCount**.

    - **OutputBuffer.FileCount** set to **Open.File.Volume.FileCount**.

    - **OutputBuffer.FsFormatMajVersion** set to **Open.File.Volume.FsFormatMajVersion**.

    - **OutputBuffer.FsFormatMinVersion** set to **Open.File.Volume.FsFormatMinVersion**.

    - **OutputBuffer.FsFormatName** set to the Unicode string "UDF".

    - **OutputBuffer.FormatTime** set to **Open.File.Volume.FormatTime**.

    - **OutputBuffer.LastUpdateTime** set to **Open.File.Volume.LastUpdateTime**.

    - **OutputBuffer.CopyrightInfo** set to **Open.File.Volume.CopyrightInfo**.

    - **OutputBuffer.AbstractInfo** set to **Open.File.Volume.AbstractInfo**.

    - **OutputBuffer.FormattingImplementationInfo** set to **Open.File.Volume.FormattingImplementationInfo**.

    - **OutputBuffer.LastModifyingImplementationInfo** set to **Open.File.Volume.LastModifyingImplementationInfo**.

- Upon successful completion of the operation, the object store MUST return:

  - **BytesReturned** set to *sizeof(*FILE_QUERY_ON_DISK_VOL_INFO_BUFFER*)*.

  - **Status** set to STATUS_SUCCESS.

### 3.1.5.9.17  FSCTL_QUERY_SPARING_INFO

The server provides:

- **Open:** An **Open** of a DataFile.

- **OutputBufferSize:** The maximum number of bytes to return in **OutputBuffer**.

On completion, the object store MUST return:

- **Status:** An NTSTATUS code that specifies the result.

- **OutputBuffer:** An array of bytes that will return a FILE_QUERY_SPARING_BUFFER as defined in [MS-FSCC] section 2.3.38.

- **BytesReturned:** The number of bytes returned in **OutputBuffer**.

Support for this operation is optional. If the object store does not implement this functionality, the operation MUST be failed with STATUS_INVALID_DEVICE_REQUEST.<35>

Pseudocode for the operation is as follows:

- If **OutputBufferSize** is less than *sizeof(*FILE_QUERY_SPARING_BUFFER*)*, the operation MUST be failed with STATUS_INVALID_PARAMETER.

- The object store MUST populate the fields of **OutputBuffer** as follows:

  - **OutputBuffer.SparingUnitBytes** set to **Open.File.Volume.SparingUnitBytes**.

  - **OutputBuffer.SoftwareSparing** set to **Open.File.Volume.SoftwareSparing**.

  - **OutputBuffer.TotalSpareBlocks** set to **Open.File.Volume.TotalSpareBlocks**.

  - **OutputBuffer.FreeSpareBlocks** set to **Open.File.Volume.FreeSpareBlocks**.

- Upon successful completion of the operation, the object store MUST return:

  - **BytesReturned** set to *sizeof(:* FILE_QUERY_SPARING_BUFFER*)*.

  - **Status** set to STATUS_SUCCESS.

### 3.1.5.9.18  FSCTL_READ_FILE_USN_DATA

The server provides:

- **Open:** An **Open** of a DataFile or DirectoryFile.

- **OutputBufferSize:** The maximum number of bytes to return in **OutputBuffer**.

On completion, the object store MUST return:

- **Status:** An NTSTATUS code that specifies the result.

- **OutputBuffer:** An array of bytes that will return a USN_RECORD as defined in [MS-FSCC] section 2.3.36.

- **BytesReturned:** The number of bytes returned in **OutputBuffer**.

Support for this operation is optional. If the object store does not implement this functionality, the operation MUST be failed with STATUS_INVALID_DEVICE_REQUEST.<36>

This operation uses the following local variables:

- Unicode string: *LinkNameToUse*

- 32-bit unsigned integers: *LinkNameLength*, *RecordLength*

Pseudocode for the operation is as follows:

If **OutputBufferSize** is less than *sizeof(*USN_RECORD*)*, the operation MUST be failed with STATUS_BUFFER_TOO_SMALL.

The object store MUST choose a link name to use in constructing the reply, as shown in the following pseudocode:

- Set *LinkNameToUse* to empty.

- For each *Link* in **Open.File.LinkList**:

  - If *Link*.**ShortName** is not empty:

    - Set *LinkNameToUse* to *Link*.**Name**.

    - Break out of the For loop.

  - ElseIf *LinkNameToUse* is empty:

    - Set *LinkNameToUse* to *Link*.**Name**.

  - EndIf

- EndFor

Set *LinkNameLength* to the length, in bytes, of *LinkNameToUse*.

Set *RecordLength* to **BlockAlign(FieldOffset(**USN_RECORD.FileName*)* + *LinkNameLength*, 8*)*.

If **OutputBufferSize** is less than *RecordLength*, the operation MUST be failed with STATUS_INFO_LENGTH_MISMATCH.

The object store MUST fill in the fields of **OutputBuffer** as follows:

- **OutputBuffer.RecordLength** set to *RecordLength*.

- **OutputBuffer.MajorVersion** set to 2.

- **OutputBuffer.MinorVersion** set to 0.

- **OutputBuffer.FileReferenceNumber** set to **Open.File.FileID**.

- **OutputBuffer.ParentFileReferenceNumber** set to **Open.Link.ParentFile.FileID**.

- **OutputBuffer.Usn** set to **Open.File.Usn**.

- **OutputBuffer.TimeStamp** set to 0.

- **OutputBuffer.Reason** set to 0.

- **OutputBuffer.SourceInfo** set to 0.

- **OutputBuffer.SecurityId** set to 0.

- **OutputBuffer.FileAttributes** set to **Open.File.FileAttributes**, or to FILE_ATTRIBUTE_NORMAL if **Open.File.FileAttributes** is 0.

- **OutputBuffer.FileNameLength** set to *RecordLength*.

- **OutputBuffer.FileName** set to *LinkNameToUse*.

- Padding bytes of zeroes to bring the total number of bytes written into **OutputBuffer** up to *RecordLength*.

Upon successful completion of the operation, the object store MUST return:

- **BytesReturned** set to *RecordLength*.

- **Status** set to STATUS_SUCCESS.

### 3.1.5.9.19   FSCTL_RECALL_FILE

The server provides:

- **Open:** An **Open** of a DataFile.

On completion, the object store MUST return:

- **Status:** An NTSTATUS code that specifies the result.

Support for this operation is optional. If the object store does not implement this functionality, the operation MUST be failed with STATUS_INVALID_DEVICE_REQUEST.<37>

Pseudocode for the operation is as follows:

If **Open.File.FileType** is DirectoryFile, the operation MUST be failed with
    STATUS_INVALID_HANDLE.

        If **Open.File.FileAttributes.FILE_ATTRIBUTE_OFFLINE** is not set:


            // The file has already been recalled.

        Else


            Recall **Open.File** from remote storage.

            Clear **Open.File.FileAttributes.FILE_ATTRIBUTE_OFFLINE**

        EndIf

Upon successful completion of the operation, the object store MUST return:

- **Status** set to STATUS_SUCCESS.

### 3.1.5.9.20 FSCTL_SET_COMPRESSION

The server provides:

- **Open:** An **Open** of a DataFile or DirectoryFile.

- **InputBuffer:** An array of bytes containing a USHORT value indicating the requested compression state of the stream, as specified in [MS-FSCC] section 2.3.43.

- **InputBufferSize:** The number of bytes in **InputBuffer**.

On completion, the object store MUST return:

- **Status:** An NTSTATUS code that specifies the result.

Support for this operation is optional. If the object store does not implement this functionality, the operation MUST be failed with STATUS_INVALID_DEVICE_REQUEST.<38>

The operation MUST be failed with STATUS_INVALID_PARAMETER under any of the following conditions:

- **InputBufferSize** is less than *sizeof(*USHORT*)* (2 bytes).

- **InputBuffer.CompressionState** is not one of the predefined values in [MS-FSCC] section 2.3.45.

Pseudocode for the operation is as follows:

- If **InputBuffer.CompressionState** != COMPRESSION_FORMAT_NONE:

  - If compression support is disabled in the object store,<39> the operation MUST be failed with STATUS_COMPRESSION_DISABLED.

  - If **Open.File.Volume.ClusterSize** is greater than 4,096, the operation MUST be failed with STATUS_INVALID_DEVICE_REQUEST, because compression is not supported on volumes with a cluster size greater than 4 KB.

- EndIf

- If **Open.File.Volume.IsReadOnly** is TRUE, the operation MUST be failed with STATUS_MEDIA_WRITE_PROTECTED.

- If **Open.Stream.IsEncrypted** is TRUE, the operation MUST be failed with STATUS_INVALID_DEVICE_REQUEST.

- If (**InputBuffer.CompressionState** == COMPRESSION_FORMAT_NONE and **Open.Stream.IsCompressed** is FALSE) or (**InputBuffer.CompressionState** != COMPRESSION_FORMAT_NONE and **Open.Stream.IsCompressed** is TRUE), the operation MUST return STATUS_SUCCESS at this point.

- The object store MUST initialize *ChangedAllocation* to FALSE.

- The object store MUST post a USN change as per section [3.1.4.11](#) with **File** equal to **File**, **Reason** equal to USN_REASON_COMPRESSION_CHANGE, and **FileName** equal to **Open.Link.Name**.

- If **InputBuffer.CompressionState** != COMPRESSION_FORMAT_NONE:

  - If **Open.Stream.AllocationSize** is less than **BlockAlign**(**Open.Stream.AllocationSize**, **Open.File.Volume.CompressionUnitSize**), the object store MUST increase **Open.Stream.AllocationSize** to **BlockAlign**(**Open.Stream.AllocationSize**, **Open.File.Volume.CompressionUnitSize**). If there is not enough disk space, the operation MUST be failed with STATUS_DISK_FULL; otherwise the object store MUST set *ChangedAllocation* to TRUE.

- EndIf

- If **InputBuffer.CompressionState** == COMPRESSION_FORMAT_NONE, the object store MUST set **Open.Stream.IsCompressed** to FALSE; otherwise it MUST be set to TRUE.

- If **Open.Stream.StreamType** is DirectoryStream or **Open.Stream.Name** is empty, the object store MUST propagate the compression state to **Open.File**:

  - If **Open.Stream.IsCompressed** is TRUE, the object store MUST set **Open.File.FileAttributes**.FILE_ATTRIBUTE_COMPRESSED to TRUE; otherwise it MUST be set to FALSE.

- EndIf

- Send directory change notification as per section [3.1.4.1](#), with **Volume** equal to **Open.File.Volume**, **Action** equal to FILE_ACTION_MODIFIED, **FilterMatch** equal to FILE_NOTIFY_CHANGE_ATTRIBUTES, and **FileName** equal to **Open.FileName**.

- If **Open.Stream.StreamType** is DirectoryStream, the operation MUST return STATUS_SUCCESS at this point.

- If **Open.Stream.IsCompressed** is FALSE and **Open.Stream.AllocationSize** is greater than **BlockAlign**(**Open.Stream.Size**, **Open.File.Volume.ClusterSize**), the object store SHOULD free excess allocation by setting **Open.Stream.AllocationSize** to **BlockAlign**(**Open.Stream.Size**, **Open.File.Volume.ClusterSize**). If any allocation is freed in this way, the object store MUST set *ChangedAllocation* to TRUE.

- If **Open.Stream.IsSparse** is TRUE, the object store SHOULD free any allocated compression unit-aligned extents beyond **Open.Stream.ValidDataLength**. If any allocation is freed in this way, the object store MUST set *ChangedAllocation* to TRUE.

- If *ChangedAllocation* is TRUE and **Open.Stream.Name** is empty, the object store MUST set **Open.File.PendingNotifications.**FILE_NOTIFY_CHANGE_SIZE to TRUE.

- Upon successful completion of the operation, the object store MUST return:

  - **Status** set to STATUS_SUCCESS.

### 3.1.5.9.21   FSCTL_SET_DEFECT_MANAGEMENT

The server provides:

- **Open:** An **Open** of a DataStream.

- **InputBuffer:** An array of bytes containing a Boolean as specified in [MS-FSCC] section 2.3.47.

- **InputBufferSize:** The number of bytes in **InputBuffer**.

On completion, the object store MUST return:

- **Status:** An NTSTATUS code that specifies the result.

Support for this operation is optional. If the object store does not implement this functionality or the target media is not a software defect-managed media, the operation MUST be failed with STATUS_INVALID_DEVICE_REQUEST.<40>

Pseudocode for the operation is as follows:

- If **Open.Stream.StreamType** is DirectoryStream, the operation MUST be failed with STATUS_INVALID_PARAMETER.

- If **InputBufferSize** is less than *sizeof(*Boolean*)* (1 byte), the operation MUST be failed with STATUS_INVALID_PARAMETER.

- If **Open.File.OpenList** contains more than one Open on this stream, this operation MUST be failed with STATUS_SHARING_VIOLATION.

- The object store MUST set **Open.File.DisableDefectManagement** to **InputBuffer.Disable**.

- Upon successful completion of the operation, the object store MUST return:

  - **Status** set to STATUS_SUCCESS.

### 3.1.5.9.22   FSCTL_SET_ENCRYPTION

The server provides:

- **Open:** An **Open** of a DataFile or DirectoryFile.

- **InputBuffer:** An array of bytes containing an ENCRYPTION_BUFFER structure indicating the requested encryption state of the stream or file, as specified in [MS-FSCC] section 2.3.47.

- **InputBufferSize:** The number of bytes in **InputBuffer**.

On completion, the object store MUST return:

- **Status:** An NTSTATUS code that specifies the result.

Support for this operation is optional. If the object store does not implement this functionality, the operation MUST be failed with STATUS_INVALID_DEVICE_REQUEST.<41>

Pseudocode for the operation is as follows:

- If **Open.File.Volume.IsReadOnly** is TRUE, the operation MUST be failed with STATUS_MEDIA_WRITE_PROTECTED.

- If **InputBufferSize** is smaller than *BlockAlign(sizeof(*ENCRYPTION_BUFFER*)*, 4*)*, the operation MUST be failed with STATUS_BUFFER_TOO_SMALL.

- The operation MUST be failed with STATUS_INVALID_PARAMETER under any of the following conditions:

- If **InputBuffer.EncryptionOperation** is not one of the predefined values in [MS-FSCC] section 2.3.47.

- If **InputBuffer.EncryptionOperation** == STREAM_SET_ENCRYPTION and **Open.Stream.IsCompressed** is TRUE.

- If **InputBuffer.EncryptionOperation** == FILE_SET_ENCRYPTION:

  - If **Open.File.Attributes**.FILE_ATTRIBUTE_ENCRYPTED is FALSE:

    - The object store MUST set **Open.File.FileAttributes**.FILE_ATTRIBUTE_ENCRYPTED to TRUE.

    - The object store MUST set **Open.File.PendingNotifications**.FILE_NOTIFY_CHANGE_ATTRIBUTES to TRUE.

  - EndIf

- ElseIf **InputBuffer.EncryptionOperation** == FILE_CLEAR_ENCRYPTION:

  - If **Open.File.Attributes**.FILE_ATTRIBUTE_ENCRYPTED is TRUE:

    - If there exists an *ExistingStream* in **Open.File.StreamList** such that *ExistingStream*.**IsEncrypted** is TRUE, the operation MUST be failed with STATUS_INVALID_DEVICE_REQUEST.

    - The object store MUST set **Open.File.FileAttributes**.FILE_ATTRIBUTE_ENCRYPTED to FALSE.

    - The object store MUST set **Open.File.PendingNotifications**.FILE_NOTIFY_CHANGE_ATTRIBUTES to TRUE.

  - EndIf

- ElseIf **InputBuffer.EncryptionOperation** == STREAM_SET_ENCRYPTION:

  - If **Open.Stream.IsEncrypted** is FALSE:

    - The object store MUST set **Open.Stream.IsEncrypted** to TRUE.

    - If **Open.File.Attributes**.FILE_ATTRIBUTE_ENCRYPTED is FALSE:

      - The object store MUST set **Open.File.FileAttributes**.FILE_ATTRIBUTE_ENCRYPTED to TRUE.

      - The object store MUST set **Open.File.PendingNotifications**.FILE_NOTIFY_CHANGE_ATTRIBUTES to TRUE.

    - EndIf

  - EndIf

- Else: // **InputBuffer.EncryptionOperation** == STREAM_CLEAR_ENCRYPTION

  - If **Open.Stream.IsEncrypted** is TRUE:

    - The object store MUST set **Open.Stream.IsEncrypted** to FALSE.

- If there does not exist an *ExistingStream* in **Open.File.StreamList** such that *ExistingStream*.**IsEncrypted** is TRUE:

    - The object store MUST set **Open.File.FileAttributes**.FILE_ATTRIBUTE_ENCRYPTED to FALSE.

    - The object store MUST set **Open.File.PendingNotifications**.FILE_NOTIFY_CHANGE_ATTRIBUTES to TRUE.

    - EndIf

- EndIf

- EndIf

- If **Open.File.PendingNotifications** is nonzero:

    - Set *FilterMatch* = (**Open.File.PendingNotifications** | **Open.Link.PendingNotifications**).

    - Send directory change notification as per section 3.1.4.1, with **Volume** equal to **Open.File.Volume**, **Action** equal to FILE_ACTION_MODIFIED, **FilterMatch** equal to *FilterMatch*, and **FileName** equal to **Open.FileName**.

    - For each *ExistingLink* in **Open.Link.ParentFile.DirectoryList**:

        - If *ExistingLink* is not equal to **Open.Link**:

            - *ExistingLink*.**PendingNotifications** |= **Open.File.PendingNotifications**

        - EndIf

    - EndFor

    - Set **Open.Link.PendingNotifications** to zero.

    - Set **Open.File.PendingNotifications** to zero.

- EndIf

- The object store MUST post a USN change as per section 3.1.4.11 with **File** equal to **File**, **Reason** equal to USN_REASON_COMPRESSION_CHANGE, and **FileName** equal to **Open.Link.Name**.

- Upon successful completion of this operation, the object store MUST return:

    - **Status** set to STATUS_SUCCESS.

### 3.1.5.9.23   FSCTL_SET_OBJECT_ID

The server provides:

- **Open:** An **Open** of a DataFile or DirectoryFile.

- **InputBuffer:** An array of bytes containing a FILE_OBJECTID_BUFFER structure as specified in [MS-FSCC] section 2.1.3.

- **InputBufferSize:** The number of bytes in **InputBuffer**.

On completion, the object store MUST return:

- **Status:** An NTSTATUS code that specifies the result.

Support for this operation is optional. If the object store does not implement this functionality, the operation MUST be failed with STATUS_INVALID_DEVICE_REQUEST.<42>

Pseudocode for the operation is as follows:

- If **InputBufferSize** is not equal to *sizeof(*FILE_OBJECTID_BUFFER*)*, the operation MUST be failed with STATUS_INVALID_PARAMETER.

- If **Volume.IsReadOnly** is TRUE, the operation MUST be failed with STATUS_MEDIA_WRITE_PROTECTED.

- If **Open.File.Volume.IsObjectIDsSupported** is FALSE, the operation MUST be failed with STATUS_VOLUME_NOT_UPGRADED.

- If **Open.HasRestoreAccess** is FALSE, the operation MUST be failed with STATUS_ACCESS_DENIED.

- If **Open.File.ObjectId** is not empty, the operation MUST be failed with STATUS_OBJECT_NAME_COLLISION.

- If **InputBuffer.ObjectId** is not unique on **Open.File.Volume**, the operation MUST be failed with STATUS_DUPLICATE_NAME.

- Before completing the operation successfully, the object store MUST set:

  - **Open.File.LastChangeTime** to the current time.<43>

  - Post a USN change as per section 3.1.4.11 with **File** equal to **File**, **Reason** equal to USN_REASON_OBJECT_ID_CHANGE, and **FileName** equal to **Open.Link.Name**.

  - **Open.File.ObjectId** to **InputBuffer.ObjectId**.

  - **Open.File.BirthVolumeId** to **InputBuffer.BirthVolumeId**.

  - **Open.File.BirthObjectId** to **InputBuffer.BirthObjectId**.

  - **Open.File.DomainId** to **InputBuffer.DomainId**.

Upon successful completion of the operation, the object store MUST return:

- **Status** set to STATUS_SUCCESS.

### 3.1.5.9.24   FSCTL_SET_OBJECT_ID_EXTENDED

The server provides:

- **Open:** An **Open** of a DataFile or DirectoryFile.

- **InputBuffer:** An array of bytes containing a FILE_OBJECTID_BUFFER structure as specified in [MS-FSCC] section 2.1.3.1.

- **InputBufferSize:** The number of bytes in **InputBuffer**.

On completion, the object store MUST return:

- **Status:** An NTSTATUS code that specifies the result.

Support for this operation is optional. If the object store does not implement this functionality, the operation MUST be failed with STATUS_INVALID_DEVICE_REQUEST.<44>

Pseudocode for the operation is as follows:

- If **InputBufferSize** is not equal to **sizeof(**ObjectId.ExtendedInfo**)** (48 bytes), the operation MUST be failed with STATUS_INVALID_PARAMETER.

- If **Volume.IsReadOnly** is TRUE, the operation MUST be failed with STATUS_MEDIA_WRITE_PROTECTED.

- If **Open.File.Volume.IsObjectIDsSupported** is FALSE, the operation MUST be failed with STATUS_VOLUME_NOT_UPGRADED.

- If **Open.GrantedAccess** contains neither FILE_WRITE_DATA nor FILE_WRITE_ATTRIBUTES, the operation MUST be failed with STATUS_ACCESS_DENIED.

- If **Open.File.ObjectId** is empty, the operation MUST be failed with STATUS_OBJECTID_NOT_FOUND.

Before completing the operation successfully, the object store MUST set:

- **Open.File.LastChangeTime** to the current time.<45>

- Post a USN change as per section 3.1.4.11 with **File** equal to **File**, **Reason** equal to USN_REASON_OBJECT_ID_CHANGE, and **FileName** equal to **Open.Link.Name**.

- **Open.File.BirthVolumeId** to **InputBuffer.BirthVolumeId**.

- **Open.File.BirthObjectId** to **InputBuffer.BirthObjectId**.

- **Open.File.DomainId** to **InputBuffer.DomainId**.

Upon successful completion of this operation, the object store MUST return:

- **Status** set to STATUS_SUCCESS.

### 3.1.5.9.25   FSCTL_SET_REPARSE_POINT

The server provides:

- **Open:** An **Open** of a DataFile or DirectoryFile.

- **InputBufferSize:** The byte count of the **InputBuffer**.

- **InputBuffer:** An array of bytes containing a REPARSE_DATA_BUFFER or REPARSE_GUID_DATA_BUFFER structure as defined in [MS-FSCC] sections 2.1.2.2 and 2.1.2.3, respectively.

On completion, the object store **MUST** return:

- **Status:** An NTSTATUS code that specifies the result.

Support for this operation is optional. If the object store does not implement this functionality, the operation MUST be failed with STATUS_INVALID_DEVICE_REQUEST.<46>

Pseudocode for the operation is as follows:

- Phase 1 -- Verify the parameters

- If (**Open.GrantedAccess** & (FILE_WRITE_DATA | FILE_WRITE_ATTRIBUTES)) == 0, the operation MUST be failed with STATUS_ACCESS_DENIED.

- If **Open.File.Volume.IsReadOnly** is TRUE, the operation MUST be failed with STATUS_MEDIA_WRITE_PROTECTED.

- If **Open.File.Volume.IsReparsePointsSupported** is FALSE, the operation MUST be failed with STATUS_VOLUME_NOT_UPGRADED.

- If **InputBufferSize** is smaller than 8 bytes, the operation MUST be failed with STATUS_IO_REPARSE_DATA_INVALID.

- If **InputBufferSize** is larger than 16384 bytes, the operation MUST be failed with STATUS_IO_REPARSE_DATA_INVALID.

- If (**InputBufferSize** != **InputBuffer.ReparseDataLength** + 8) && (**InputBufferSize** != **InputBuffer.ReparseDataLength** + 24), the operation MUST be failed with STATUS_IO_REPARSE_DATA_INVALID.

- If **InputBuffer.ReparseTag** == IO_REPARSE_TAG_MOUNT_POINT and **Open.File.FileType** != DirectoryFile, the operation MUST be failed with STATUS_NOT_A_DIRECTORY.

- If **InputBuffer.ReparseTag** == IO_REPARSE_TAG_SYMLINK and **Open.HasCreateSymbolicLinkAccess** is FALSE, the operation MUST be failed with STATUS_ACCESS_DENIED.

- If **Open.File.FileType** == DirectoryFile and **Open.File.DirectoryList** is not empty, the operation MUST be failed with STATUS_DIRECTORY_NOT_EMPTY.

- **If Open.File.FileType** == DataFile and **InputBuffer.ReparseTag** == IO_REPARSE_TAG_SYMLINK and **Open.Stream.Size** is nonzero, the operation MUST be failed with STATUS_IO_REPARSE_DATA_INVALID.

- If **Open.File.FileAttributes.** FILE_ATTRIBUTE_REPARSE_POINT is not set and **Open.File.ExtendedAttributesLength** is nonzero, the operation MUST be failed with STATUS_EAS_NOT_SUPPORTED.

- Phase 2 -- Update the File

- If **Open.File.ReparseTag** is not empty (indicating that a reparse point is already assigned):

  - If **Open.File.ReparseTag** != **InputBuffer.ReparseTag**, the operation MUST be failed with STATUS_IO_REPARSE_TAG_MISMATCH.

  - If **Open.File.ReparseTag** is a non-Microsoft tag and **Open.File.ReparseGUID** is not equal to **InputBuffer.ReparseGUID**, the operation MUST be failed with STATUS_REPARSE_ATTRIBUTE_CONFLICT.

  - Copy **InputBuffer.DataBuffer** to **Open.File.ReparseData**.

- Else

  - Set **Open.File.ReparseTag** to **InputBuffer.ReparseTag**.

  - If **InputBuffer.ReparseTag** is a non-Microsoft Tag, then set **Open.File.ReparseGUID** to **InputBuffer.ReparseGUID**.

- Set **Open.File.ReparseData** to **InputBuffer.ReparseData**.

- Set **Open.File.FileAttributes**.FILE_ATTRIBUTE_REPARSE_POINT to TRUE.

- EndIf

- Set **Open.File.FileAttributes**.FILE_ATTRIBUTE_ARCHIVE to TRUE.

- Update **Open.File.LastChangeTime** to the current system time.<47>

Upon successful completion of the operation, the object store MUST return:

- **Status** set to STATUS_SUCCESS.

### 3.1.5.9.26   FSCTL_SET_SHORT_NAME_BEHAVIOR

This control code is reserved for the **WinPE**<48>environment; the object store MUST return STATUS_INVALID_DEVICE_REQUEST.

### 3.1.5.9.27   FSCTL_SET_SPARSE

The server provides:

- **Open:** An **Open** of a DataStream.

- **InputBufferSize:** The byte count of the **InputBuffer**.

- **InputBuffer:** A buffer of type FILE_SET_SPARSE_BUFFER as defined in [MS-FSCC] section 2.3.55.

On completion, the object store **MUST** return:

- **Status:** An NTSTATUS code that specifies the result.

Support for this operation is optional. If the object store does not implement this functionality, the operation MUST be failed with STATUS_INVALID_DEVICE_REQUEST.<49>

Pseudocode for the operation is as follows:

- If **Open.File.Volume.IsReadOnly** is TRUE, the object store MUST return STATUS_MEDIA_WRITE_PROTECTED.

- If **Open.GrantedAccess.FILE_WRITE_DATA** is FALSE and **Open.GrantedAccess.FILE_WRITE_ATTRIBUTES** is FALSE, the operation MUST be failed with STATUS_ACCESS_DENIED.

- The object store MUST post a USN change as per section 3.1.4.11 with **File** equal to **File**, **Reason** equal to USN_REASON_BASIC_INFO_CHANGE, and **FileName** equal to **Open.Link.Name**. If **InputBuffer.SetSparse** is TRUE:

  - The object store MUST set **Open.Stream.IsSparse** to TRUE.

  - The object store MUST set **Open.File.FileAttributes.**FILE_ATTRIBUTE_SPARSE_FILE to TRUE, indicating that at least one stream of the file is sparse.

- Else

  - For each *Extent* in **Open.Stream.ExtentList**:

- If *Extent*.LCN is un-allocated as per [MS-FSCC] 2.3.20.1:

    - The object store MUST fully allocate the *Extent*. If the space cannot be allocated, then the operation MUST be failed with STATUS_DISK_FULL. The object store is not required to revert any allocations performed during the operation.

    - EndIf

- EndFor

- The object store MUST set **Open.Stream.IsSparse** to FALSE.

- If there does not exist an *ExistingStream* in **Open.File.StreamList** such that *ExistingStream*.**IsSparse** is TRUE:

    - The object store MUST set **Open.File.FileAttributes.**FILE_ATTRIBUTE_SPARSE_FILE to FALSE, indicating that no streams of the file are sparse.

    - EndIf

- EndIf

- Set **Open.File.PendingNotifications.**FILE_NOTIFY_CHANGE_ATTRIBUTES to TRUE.

- Upon successful completion of this operation, the object store MUST return:

    - **Status** set to STATUS_SUCCESS.

### 3.1.5.9.28   FSCTL_SET_ZERO_DATA

The server provides:

- **Open:** An **Open** of a DataStream.

- **InputBufferSize:** The byte count of the **InputBuffer**.

- **InputBuffer:** An array of bytes containing a FILE_ZERO_DATA_INFORMATION structure as defined in [MS-FSCC] section 2.3.61.

On completion, the object store **MUST** return:

- **Status:** An NTSTATUS code that specifies the result.

This algorithm uses the following local variables:

- 64-bit signed integers: *StartingOffset*, *CurrentBytes*, *CurrentOffset*, *CurrentFinalByte*, *NextVcn* *CurrentVcn*, *ClusterCount*

- 64-bit signed integer initialized to -1: *LastOffset*

Support for this operation is optional. If the object store does not implement this functionality, the operation MUST be failed with STATUS_INVALID_DEVICE_REQUEST.<50>

The operation MUST be failed with STATUS_INVALID_PARAMETER under any of the following conditions:

- **InputBufferSize** is less than **sizeof(**FILE_ZERO_DATA_INFORMATION**)**.

- **InputBuffer.FileOffset** is less than 0.

- **InputBuffer.BeyondFinalZero** is less than 0.

- **InputBuffer.FileOffset** is greater than **InputBuffer.BeyondFinalZero**.

- **Open.Stream.StreamType** is not DataStream.

Pseudocode for the operation is as follows:

- If **Open.File.Volume.IsReadOnly** is TRUE, the operation MUST be failed with STATUS_MEDIA_WRITE_PROTECTED.

- Set *StartingOffset* equal to **InputBuffer.FileOffset**.

- While TRUE:

  - If **Open.Stream.IsDeleted** is TRUE, the operation MUST be failed with STATUS_FILE_DELETED.

  - If *StartingOffset* is greater than or equal to **Open.Stream.Size**, or if *StartingOffset* is greater than or equal to **InputBuffer.BeyondFinalZero**, break out of the while loop.

  - Set *CurrentBytes* to **InputBuffer.BeyondFinalZero** - *StartingOffset*.

  - If **InputBuffer.BeyondFinalZero** is greater than **Open.Stream.Size**, set *CurrentBytes* to **Open.Stream.Size** - *StartingOffset*.

  - If *CurrentBytes* is greater than 0x40000000 (1 gigabyte), set *CurrentBytes* to 0x40000000.

  - If **Open.Stream.Oplock** is not empty, the object store MUST check for an oplock break according to the algorithm in section 3.1.4.12, with input values as follows:

    - **Open** equal to this operation's **Open**

    - **Operation** equal to "FS_CONTROL"

    - **OpParams** containing a member **ControlCode** containing "FSCTL_SET_ZERO_DATA"

  - The object store MUST check for byte range lock conflicts using the algorithm described in section 3.1.4.10 with **ByteOffset** set to *StartingOffset*, **Length** set to *CurrentBytes*, **IsExclusive** set to TRUE, **LockIntent** set to FALSE and **Open** set to **Open**. If a conflict is detected, the operation MUST be failed with STATUS_FILE_LOCK_CONFLICT.

  - The object store MUST post a USN change as per section 3.1.4.11 with **File** equal to **File**, **Reason** equal to USN_REASON_DATA_OVERWRITE, and **FileName** equal to **Open.Link.Name**.

  - If *LastOffset* is -1 and *StartingOffset* is greater than **Open.Stream.ValidDataLength**:

    - Zero the data in the file according to the algorithm in section 3.1.5.9.28.1, setting the algorithm's parameters as follows:

      - Pass in the current **Open**.

      - **StartingZero** equal to **Open.Stream.ValidDataLength**.

      - **ByteCount** equal to *StartingOffset* -**Open.Stream.ValidDataLength**.

  - EndIf

- If **Open.Stream.IsCompressed** is TRUE, or if **Open.Stream.IsSparse** is TRUE:

  - Set *CurrentOffset* to *StartingOffset* & ~(**Open.File.Volume.CompressionUnitSize** - 1). This aligns the starting point to a compression unit boundary, since when setting zero ranges on a sparse or compressed file, allocation is deleted in compression unit-aligned chunks.

  - Set *CurrentFinalByte* to **InputBuffer.BeyondFinalZero**.

  - If *CurrentFinalByte* is greater than or equal to **Open.Stream.Size**, set *CurrentFinalByte* to **BlockAlign**(**Open.Stream.Size**, **Open.File.Volume.CompressionUnitSize**).

  - Set *NextVcn* and *CurrentVcn* equal to **ClustersFromBytesTruncate**(**Open.File.Volume**, *CurrentOffset*).

  - While an unallocated range of the file exists starting at *NextVcn*:

    - *NextVcn* += The size of the unallocated range in clusters.

    - If (*NextVcn* * **Open.File.Volume.ClusterSize**) is greater than or equal to *CurrentFinalByte*:

      - *NextVcn* = **ClustersFromBytesTruncate**(**Open.File.Volume**, *CurrentFinalByte*).

      - Break out of the While loop.

    - EndIf

  - EndWhile

  - *NextVcn* = **BlockAlignTruncate**(*NextVcn*, **ClustersFromBytes**(**Open.File.Volume**, **Open.File.Volume.CompressionUnitSize**) ). This aligns *NextVcn* to a compression unit boundary.

  - If *NextVcn* != *CurrentVcn*:

    - *ClusterCount* = *NextVcn* - *CurrentVcn*

    - *CurrentVcn* += *ClusterCount*

  - EndIf

  - *CurrentOffset* = (*CurrentVcn* * **Open.File.Volume.ClusterSize**)

  - If *CurrentOffset* >= *CurrentFinalByte*, break out of the while loop.

  - If *CurrentOffset* < *StartingOffset*:

    - If there are not enough free clusters on the storage media to accommodate a write of **Open.File.Volume.CompressionUnitSize** bytes, the operation MUST be failed with STATUS_DISK_FULL. The object store is not required to undo any file zeroing or range deallocation that has been performed during the operation.

    - *CurrentBytes* = **Open.File.Volume.CompressionUnitSize** - (*StartingOffset* - *CurrentOffset*)

    - If (*CurrentOffset* + **Open.File.Volume.CompressionUnitSize**) > *CurrentFinalByte*:

      - *CurrentBytes* = *CurrentFinalByte* - *StartingOffset*

- EndIf

- The object store MUST write *CurrentBytes* zeroes into the stream beginning at *CurrentOffset* + (*StartingOffset* & (**Open.File.Volume.CompressionUnitSize** - 1)).

- *CurrentOffset* += (*StartingOffset* & (**Open.File.Volume.CompressionUnitSize** - 1))

- ElseIf *CurrentOffset* + **Open.File.Volume.CompressionUnitSize** > *CurrentFinalByte*:

  - If there are not enough free clusters on the storage media to accommodate a write of **Open.File.Volume.CompressionUnitSize** bytes, the operation MUST be failed with STATUS_DISK_FULL. The object store is not required to undo any file zeroing or range deallocation that has been performed during the operation.

  - *CurrentBytes* = *CurrentFinalByte* & (**Open.File.Volume.CompressionUnitSize** - 1)

  - The object store MUST write *CurrentBytes* zeroes into the stream beginning at *CurrentOffset*.

- Else

  - *CurrentBytes* = *CurrentFinalByte* - *CurrentOffset*

  - If *CurrentBytes* is greater than 0x40000000, set *CurrentBytes* to 0x40000000.

  - *CurrentBytes* = **BlockAlignTruncate**(*CurrentBytes*, **Open.File.Volume.CompressionUnitSize**)

  - If (*CurrentBytes* != 0) and (*NextVcn* <= (*CurrentVcn* +**ClustersFromBytesTruncate**(**Open.File.Volume**, *CurrentBytes*) - 1)):

    - The object store MUST delete *CurrentVcn* + **ClustersFromBytesTruncate**(**Open.File.Volume**, *CurrentBytes*) - 1 clusters of allocation from the stream starting with the cluster at *NextVcn*.

  - EndIf

- EndIf

- Else

  - *CurrentOffset* = *StartingOffset*

  - *CurrentFinalByte* = ((*CurrentOffset* + 0x40000) & -(0x40000))

  - If *CurrentFinalByte* is greater than or equal to **Open.Stream.Size**, set *CurrentFinalByte* to **Open.Stream.Size**.

  - If *CurrentFinalByte* is greater than **InputBuffer.BeyondFinalZero**, set *CurrentFinalByte* to **InputBuffer.BeyondFinalZero**.

  - *CurrentBytes* = *CurrentFinalByte* - *CurrentOffset*

  - If *CurrentBytes* != 0 and *CurrentOffset* is less than **Open.Stream.ValidDataLength**:

    - The object store MUST write *CurrentBytes* zeroes into the stream beginning at *CurrentOffset*.

  - EndIf

- EndIf

- If *CurrentOffset + CurrentBytes* is greater than **Open.Stream.ValidDataLength** and *StartingOffset* is less than **Open.Stream.ValidDataLength**:

  - The object store MUST set **Open.Stream.ValidDataLength** equal to *CurrentOffset + CurrentBytes*.

- EndIf

- *LastOffset = StartingOffset*

- If *CurrentBytes* != 0, set *StartingOffset* equal to *CurrentOffset + CurrentBytes*.

- EndWhile

- If **Open.Mode** contains either FILE_NO_INTERMEDIATE_BUFFERING or FILE_WRITE_THROUGH, the object store MUST flush all changes to the stream made during this operation, including any file size changes, to stable storage, and MUST fail the operation if the underlying physical storage reports an error flushing the data.

- Upon successful completion of the operation, the object store MUST return:

  - **Status** set to STATUS_SUCCESS.

### 3.1.5.9.28.1   Algorithm to Zero Data Beyond ValidDataLength

This algorithm returns no value.

The inputs for the algorithm are:

- **ThisOpen:** The **Open** for the stream being zeroed.

- **StartingZero:** A 64-bit signed integer. The offset into the stream to begin zeroing.

- **ByteCount:** The number of bytes to zero.

The algorithm uses the following local variables:

- 64-bit signed integers: *ZeroStart*, *BeyondZeroEnd*, *LastCompressionUnit*, *ClustersToDeallocate*

Pseudocode for the algorithm is as follows:

- Set *ZeroStart* to **BlockAlign**(**StartingZero**, **ThisOpen.File.Volume.SectorSize**).

- Set *BeyondZeroEnd* to **BlockAlign**(**StartingZero** + **ByteCount**, **ThisOpen.File.Volume.SectorSize**).

- If (**ThisOpen.Stream.IsCompressed** is FALSE) and (**ThisOpen.Stream.IsSparse** is FALSE) and (*ZeroStart* != **StartingZero**):

  - The object store MUST write zeroes into the stream from **StartingZero** to *ZeroStart*.

- EndIf

- If ((**ThisOpen.Stream.IsCompressed** is TRUE) or

  (**ThisOpen.Stream.IsSparse** is TRUE)) and

(**ByteCount** > **ThisOpen.File.Volume.CompressionUnitSize** * 2):

- If **BlockAlign**(*ZeroStart*, **ThisOpen.File.Volume.CompressionUnitSize**) != *ZeroStart*:

    - The object store MUST write zeroes into the stream from *ZeroStart* to **BlockAlign**(*ZeroStart*, **ThisOpen.File.Volume.CompressionUnitSize**).

    - The object store MUST set **ThisOpen.Stream.ValidDataLength** to **BlockAlign**(*ZeroStart*, **ThisOpen.File.Volume.CompressionUnitSize**).

    - Set *ZeroStart* equal to **BlockAlign**(*ZeroStart*, **ThisOpen.File.Volume.CompressionUnitSize**).

- EndIf

- Set *LastCompressionUnit* equal to **BlockAlignTruncate**(*BeyondZeroEnd*, **ThisOpen.File.Volume.CompressionUnitSize**).

- Set *ClustersToDeallocate* equal to **ClustersFromBytes**(**ThisOpen.File.Volume**, *LastCompressionUnit - ZeroStart*).

- The object store MUST delete *ClusterToDeallocate* clusters of allocation from the stream starting with the cluster at **ClustersFromBytes**(**ThisOpen.File.Volume**, *ZeroStart*).

- If *LastCompressionUnit* != *BeyondZeroEnd*:

    - The object store MUST write zeroes into the stream from *LastCompressionUnit* to *BeyondZeroEnd*.

    - The object store MUST set **ThisOpen.Stream.ValidDataLength** equal to **StartingZero** + **ByteCount**.

- EndIf

- The algorithm returns at this point.

- EndIf

- If *ZeroStart = BeyondZeroEnd*

    - The algorithm returns at this point.

- EndIf

- The object store MUST write zeroes into the stream from *ZeroStart* to *BeyondZeroEnd*.

- The object store MUST set **ThisOpen.Stream.ValidDataLength** equal to **StartingZero** + **ByteCount**.

### 3.1.5.9.29   FSCTL_SET_ZERO_ON_DEALLOCATION

The server provides:

- **Open:** An **Open** of a DataStream.

On completion the object store MUST return:

- **Status:** An NTSTATUS code that specifies the result.

Support for this operation is optional. If the object store does not implement this functionality, the operation MUST be failed with STATUS_INVALID_DEVICE_REQUEST.<51>

The operation MUST be failed with STATUS_ACCESS_DENIED under either of the following conditions:

- **Open.Stream.StreamType** is not DataStream.

- **Open.GrantedAccess** contains neither FILE_WRITE_DATA nor FILE_APPEND_DATA.

Pseudocode for the operation is as follows:

- The object store MUST set **Open.Stream.ZeroOnDeallocate** to TRUE.

- Upon successful completion of the operation, the object store MUST return:

  - **Status** set to STATUS_SUCCESS.

### 3.1.5.9.30   FSCTL_SIS_COPYFILE

The server provides:

- **Open:** An **Open** of a DataStream or DirectoryStream.

- **InputBuffer:** An array of bytes containing a single SI_COPYFILE structure indicating the source and destination files to copy, as specified in [MS-FSCC] section 2.3.61.

- **InputBufferSize:** The number of bytes in **InputBuffer**.

On completion, the object store MUST return:

- **Status:** An NTSTATUS code that specifies the result.

This routine uses the following local variables:

- **Opens**: *SourceOpen*, *DestinationOpen*

The purpose of this operation is to make it look like a copy from the source file to the destination file has occurred when in reality no data is actually copied. This operation modifies the source file in such a way that the clusters associated with it can be shared across multiple files. The destination file is created and modified to point at the same shared clusters that the source file points to.<52>

Support for [SIS] is optional. If the object store does not implement this functionality, the operation MUST be failed with STATUS_INVALID_DEVICE_REQUEST.

Pseudocode for the operation is as follows:

- If **Open.IsAdministrator** is FALSE, the operation MUST be failed with STATUS_ACCESS_DEFINED.

- If **InputBufferSizes** is less than **sizeof(**SI_COPYFILE**)**, the operation MUST be failed with STATUS_INVALID_PARAMETER_1.

- If **InputBuffer.Flags** contains any flags besides COPYFILE_SIS_LINK and COPYFILE_SIS_REPLACE, the operation MUST be failed with STATUS_INVALID_PARAMETER_2.

- If **InputBuffer.SourceFileNameLength** or **InputBuffer.DestinationFileNameLength** is <= zero, the operation MUST be failed with STATUS_INVALID_PARAMETER_3.

- If **InputBuffer.SourceFileNameLength** or **InputBuffer.DestinationFileNameLength** is > MAXUSHORT (0xffff), the operation MUST be failed with STATUS_INVALID_PARAMETER.

- If *FieldOffset(***InputBuffer.SourceFileName***)* + **InputBuffer.SourceFileNameLength** + **InputBuffer.DestinationFileNameLength** is > **InputBufferSize**, the operation MUST be failed with STATUS_INVALID_PARAMETER_4.

- *SourceOpen* set to the **Open** returned from a successful call to open a file as defined in section 3.1.5.1, setting the algorithm's parameters as follows:

  - **RootOpen:** Set to **Open.RootOpen**.

  - **PathName:** Set to **InputBuffer.SourceFileName**.

  - **SecurityContext:** Set to empty.<53>

  - **DesiredAccess:** Set to GENERIC_READ.

  - **ShareAccess:** If the source file is already controlled by SIS (meaning the source file already has a reparse point of type IO_REPARSE_TAG_SIS), then set to FILE_SHARE_READ, else set to zero.

  - **CreateOptions:** Set To FILE_NON_DIRECTORY_FILE | FILE_NO_INTERMEDIATE_BUFFERING.

  - **CreateDisposition:** Set to FILE_OPEN.

  - **DesiredFileAttributes:** Set to FILE_ATTRIBUTE_NORMAL.

  - **IsCaseInsensitive:** Set to TRUE.

  - **OplockKey:** Set to Empty.

- If the request fails, this operation MUST be failed with the returned STATUS.

- The operation MUST be failed with STATUS_OBJECT_TYPE_MISMATCH under any of the following conditions:

  - If *SourceOpen*.**File.LinkList** contains more than one entry (meaning this file has hardlinks).

  - If *SourceOpen*.**Stream.IsEncrypted** is TRUE.

  - If *SourceOpen*.**File.ReparseTag** is empty or is not IO_REPARSE_TAG_SIS (as defined in [MS-FSCC] section 2.1.2.1) and **InputBuffer.Flags.COPYFILE_SIS_LINK** is TRUE.

- If *SourceOpen*.**File.ReparseTag** is not empty and is not IO_REPARSE_TAG_SIS, the operation MUST be failed with STATUS_INVALID_PARAMETER.

- *DestinationOpen* set to the **Open** returned from a successful call to create a file as defined in section 3.1.5.1, setting the algorithm's parameters as follows:

  - **RootOpen:** Set to **Open.RootOpen**.

  - **PathName:** Set to **InputBuffer.DestinationFileName**.

  - **SecurityContext:** Set to empty.<54>

  - **DesiredAccess:** Set to GENERIC_READ | GENERIC_WRITE | DELETE.

  - **ShareAccess:** Set to zero.

- **CreateOptions:** Set to FILE_NON_DIRECTORY_FILE.

- **CreateDisposition:** If **InputBuffer.Flags.COPYFILE_SIS_REPLACE** is TRUE, set to FILE_OVERWRITE_IF, else set to FILE_CREATE.

- **DesiredFileAttributes:** Set to FILE_ATTRIBUTE_NORMAL.

- **IsCaseInsensitive:** Set to TRUE.

- **OplockKey:** Set to Empty.

- If the request fails, this operation MUST be failed with the returned STATUS.

- If *SourceOpen*.**Volume** is not equal to *DestinationOpen*.**Volume** is not equal to **Open.Volume**, the operation MUST be failed with STATUS_NOT_SAME_DEVICE.

- Share the clusters between the source and destination file.<55>

- *DestinationOpen*.**ReparseTag** set to IO_REPARSE_TAG_SIS.

- Upon successful completion of the operation, the object store MUST return:

  - **Status** set to STATUS_SUCCESS.

### 3.1.5.9.31   FSCTL_WRITE_USN_CLOSE_RECORD

The server provides:

- **Open:** An **Open** of a DataStream or DirectoryStream.

- **OutputBufferSize:** The maximum number of bytes to return in **OutputBuffer**.

On completion, the object store MUST return:

- **Status:** An NTSTATUS code that specifies the result.

- **OutputBuffer:** An array of bytes that will return a **Usn** structure representing the current USN of the file, as specified in [MS-FSCC] section 2.3.64.

- **BytesReturned:** The number of bytes returned in **OutputBuffer**.

Support for this operation is optional. If the object store does not implement this functionality, the operation MUST be failed with STATUS_INVALID_DEVICE_REQUEST.<56>

Pseudocode for the operation is as follows:

- If **Open.File.Volume.IsReadOnly** is TRUE, the operation MUST be failed with STATUS_MEDIA_WRITE_PROTECTED.

- If **OutputBufferSize** is less than *sizeof(***Usn***)*, the operation MUST be failed with STATUS_INVALID_PARAMETER.

- If **Open.File.Volume.IsUsnJournalActive** is FALSE, the operation MUST be failed with STATUS_JOURNAL_NOT_ACTIVE.

- The object store MUST post a USN change as per section 3.1.4.11 with **File** equal to **File**, **Reason** equal to USN_REASON_CLOSE, and **FileName** equal to **Open.Link.Name**.

- The object store MUST populate the fields of **OutputBuffer** as follows:

- **OutputBuffer.Usn** set to **Open.File.Usn**.

- Upon successful completion of the operation, the object store MUST return:

  - **BytesReturned** set to *sizeof(***Usn***)*.

  - **Status** set to STATUS_SUCCESS.

### 3.1.5.10   Server Requests Change Notifications for a Directory

The server provides:

- **Open:** An **Open** of a DirectoryStream.

- **OutputBufferSize:** The maximum number of bytes to return in **OutputBuffer**.

- **WatchTree:** A Boolean indicating whether the directory should be monitored recursively.

- **CompletionFilter:** A 32-bit unsigned integer composed of flags indicating the types of changes to monitor as specified in [MS-SMB2] section 2.2.35.

On completion, the object store MUST return:

- **Status:** An NTSTATUS code that specifies the result.

- **OutputBuffer:** An array of bytes containing the notification data.

- **ByteCount:** The count of the bytes in the array.

Pseudocode for the operation is as follows:

- The **Open.File.Volume.ChangeNotifyList** MUST be searched for a **ChangeNotifyEntry** where **ChangeNotifyEntry.OpenedDirectory** matches **Open**.

- If there were no matching **ChangeNotifyEntries**, one MUST be constructed so that:

  - **ChangeNotifyEntry.OpenedDirectory** points to **Open**.

  - **ChangeNotifyEntry.WatchTree** is set to **WatchTree**.

  - **ChangeNotifyEntry.CompletionFilter** is set to **CompletionFilter**.

  - **ChangeNotifyEntry.NotifyEventList** is initialized to an empty list.

  - Insert **ChangeNotifyEntry** at the end of **Open.File.Volume.ChangeNotifyList**.

- EndIf

- Insert operation into **CancelableOperations.CancelableOperationList**.

- Wait for a Change Notify per section 3.1.5.10.1

### 3.1.5.10.1   Waiting for Change Notification to be Reported

Wait until the following conditions are satisfied:

- There are one or more elements in **ChangeNotifyEntry.NotifyEventList**.

- This change notification request is the oldest outstanding request on this **Open**. This means multiple change notification requests on the same **Open** are completed sequentially and in first-in-first-out (FIFO) order.

- The operation is canceled per section 3.1.5.19.

Pseudocode for the operation is as follows:

- When a **ChangeNotifyEntry**.**NotifyEventList** element is available:

  - If all entries from ChangeNotifyEntry.NotifyEventList fit in OutputBufferSize bytes:

    - Remove all NotifyEventEntries from ChangeNotifyEntry.NotifyEventList.

    - Copy NotifyEventEntries to OutputBuffer.

    - Set Status to STATUS_SUCCESS.

    - Set ByteCount to the size of OutputBuffer, in bytes.

  - Else:

    - Set **Status** to STATUS_NOTIFY_ENUM_DIR.

    - Set **ByteCount** to zero.

  - EndIf

- EndIf

### 3.1.5.11   Server Requests a Query of File Information

The server provides:

- **Open:** An **Open** of a DataStream or DirectoryStream.

- **OutputBufferSize:** The maximum number of bytes to be returned in **OutputBuffer**.

- **FileInformationClass:** The type of information being queried, as specified in [MS-FSCC] section 2.4.

On completion, the object store MUST return:

- **Status:** An NTSTATUS code that specifies the result.

- **OutputBuffer:** An array of bytes containing the file information. The structure of these bytes is dependent on **FileInformationClass**, as noted in the relevant subsection.

- **ByteCount:** The number of bytes stored in **OutputBuffer**.

If **FileInformationClass** is not defined in [MS-FSCC] section 2.4, the operation MUST be failed with STATUS_INVALID_INFO_CLASS.

### 3.1.5.11.1   FileAccessInformation

**OutputBuffer** is of type FILE_ACCESS_INFORMATION as described in [MS-FSCC] 2.4.1.

Pseudocode for the operation is as follows:

- If **OutputBufferSize** is smaller than *sizeof(*FILE_ACCESS_INFORMATION*)*, the operation MUST be failed with STATUS_INFO_LENGTH_MISMATCH.

- **OutputBuffer** MUST be filled out as follows:

  - **OutputBuffer.AccessFlags** set to **Open.GrantedAccess**.

- Upon successful completion of the operation, the object store MUST return:

  - **ByteCount** set to *sizeof(*FILE_ACCESS_INFORMATION*)*

  - **Status** set to STATUS_SUCCESS.

### 3.1.5.11.2   FileAlignmentInformation

**OutputBuffer** of type FILE_ALIGNMENT_INFORMATION as described in [MS-FSCC] section 2.4.3.

Pseudocode for the operation is as follows:

- If **OutputBufferSize** is smaller than *sizeof(*FILE_ALIGNMENT_INFORMATION*)*, the operation MUST be failed with Status STATUS_INFO_LENGTH_MISMATCH.

- **OutputBuffer** MUST be filled out as follows:

  - **OutputBuffer.AlignmentRequirement** set to one of the alignment requirement values specified in [MS-FSCC] section 2.4.3 based on the characteristics of the device on which the File is stored.

- Upon successful completion of the operation, the object store MUST return:

  - **ByteCount** set to *sizeof(*FILE_ALIGNMENT_INFORMATION*)*.

  - **Status** set to STATUS_SUCCESS.

### 3.1.5.11.3   FileAllInformation

**OutputBuffer** is of type FILE_ALL_INFORMATION as described in [MS-FSCC] 2.4.2.

Pseudocode for the operation is as follows:

- If **OutputBufferSize** is smaller than *BlockAlign(**FieldOffset(*FILE_ALL_INFORMATION.NameInformation.FileName*) + 2, 8*)*, the operation MUST be failed with STATUS_INFO_LENGTH_MISMATCH.

- The object store MUST populate the fields of **OutputBuffer** as follows:

  - **OutputBuffer.BasicInformation** MUST be filled using the algorithm described in section 3.1.5.11.6.

  - **OutputBuffer.StandardInformation** MUST be filled using the operation described in section 3.1.5.11.27.

  - **OutputBuffer.InternalInformation** MUST be filled using the operation described in section 3.1.5.11.17.

  - **OutputBuffer.EaInformation** MUST be filled using the operation described in section 3.1.5.11.10.

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- **OutputBuffer.AccessInformation** MUST be filled using the operation described in section [3.1.5.11.1](#).

- **OutputBuffer.PositionInformation** MUST be filled using the operation described in section [3.1.5.11.23](#).

- **OutputBuffer.ModeInformation** MUST be filled using the operation described in section [3.1.5.11.18](#).

- **OutputBuffer.AlignmentInformation** MUST be filled using the operation described in section [3.1.5.11.2](#).

- **OutputBuffer.NameInformation** MUST be filled using the operation described in section [3.1.5.11.19](#), saving the returned ByteCount in *NameInformationLength* and the returned Status in *NameInformationStatus*.

- Upon successful completion of the operation, the object store MUST return:

  - **ByteCount** set to *FieldOffset(*FILE_ALL_INFORMATION.NameInformation*)* + *NameInformationLength*.

  - **Status** set to *NameInformationStatus*.

### 3.1.5.11.4   FileAlternateNameInformation

**OutputBuffer** is of type FILE_NAME_INFORMATION as described in [MS-FSCC] [2.4.5](#).

Pseudocode for the operation is as follows:

- If **OutputBufferSize** is smaller than **BlockAlign(*FieldOffset(*FILE_NAME_INFORMATION.FileName*)* + 2, 4*)*, the operation MUST be failed with STATUS_INFO_LENGTH_MISMATCH.

- If **Open.Link.ShortName** is empty, the operation MUST be failed with STATUS_OBJECT_NAME_NOT_FOUND.

- **OutputBuffer** MUST be filled out as follows:

  - **OutputBuffer.FileNameLength** set to the length, in bytes, of **Open.Link.ShortName**.

  - **OutputBuffer.FileName** set to **Open.Link.ShortName**.

- Upon successful completion of the operation, the object store MUST return:

  - **ByteCount** set to *FieldOffset(*FILE_NAME_INFORMATION.FileName*)* + **OutputBuffer.FileNameLength**.

  - **Status** set to STATUS_SUCCESS.

### 3.1.5.11.5   FileAttributeTagInformation

**OutputBuffer** is of type FILE_ATTRIBUTE_TAG_INFORMATION as defined in [MS-FSCC] section 2.4.6.

Pseudocode for the operation is as follows:

- If **OutputBufferSize** is smaller than *sizeof(*FILE_ATTRIBUTE_TAG_INFORMATION*)*, the operation MUST be failed with STATUS_INFO_LENGTH_MISMATCH.

- If **Open.GrantedAccess** does not contain FILE_READ_ATTRIBUTES, the operation MUST be failed with STATUS_ACCESS_DENIED.

- If **Open.Stream.StreamType** is DirectoryStream:

  - The object store MUST set **OutputBuffer.FileAttributes** equal to the value of **Open.File.FileAttributes**.

  - The object store MUST set FILE_ATTRIBUTE_DIRECTORY in **OutputBuffer.FileAttributes**.

- Else:

  - This is a DataStream. The object store MUST set **OutputBuffer.FileAttributes** equal to the value of **Open.File.FileAttributes**. The following attribute values, if they are set in **Open.File.FileAttributes**, MUST NOT be copied to **OutputBuffer.FileAttributes** (attribute flags are defined in [MS-FSCC] section 2.6):

    - FILE_ATTRIBUTE_COMPRESSED

    - FILE_ATTRIBUTE_TEMPORARY

    - FILE_ATTRIBUTE_SPARSE_FILE

    - FILE_ATTRIBUTE_ENCRYPTED

  - If **Open.Stream.IsSparse** is TRUE, the object store MUST set FILE_ATTRIBUTE_SPARSE_FILE in **OutputBuffer.FileAttributes**.

  - If **Open.Stream.IsEncrypted** is TRUE, the object store MUST set FILE_ATTRIBUTE_ENCRYPTED in **OuputBuffer.FileAttributes**.

  - If **Open.Stream.IsTemporary** is TRUE, the object store MUST set FILE_ATTRIBUTE_TEMPORARY in **OutputBuffer.FileAttributes**.

  - If **Open.Stream.IsCompressed** is TRUE, the object store MUST set FILE_ATTRIBUTE_COMPRESSED in **OutputBuffer.FileAttributes**.

- EndIf

- If **OutputBuffer.FileAttributes** is 0, the object store MUST set FILE_ATTRIBUTE_NORMAL in **OutputBuffer.FileAttributes**.

- **OutputBuffer.ReparseTag** MUST be set to **Open.File.ReparseTag**.

- Upon successful completion of the operation, the object store MUST return:

  - **ByteCount** set to *sizeof(*FILE_ATTRIBUTE_TAG_INFORMATION*)*.

  - **Status** set to STATUS_SUCCESS.

### 3.1.5.11.6   FileBasicInformation

**OutputBuffer** is of type FILE_BASIC_INFORMATION as defined in [MS-FSCC] section 2.4.7.

Pseudocode for the operation is as follows:

- If **OutputBufferSize** is smaller than **BlockAlign**(**sizeof(**FILE_BASIC_INFORMATION**)**, 8**)**, the operation MUST be failed with STATUS_INFO_LENGTH_MISMATCH.

- If **Open.GrantedAccess** does not contain FILE_READ_ATTRIBUTES, the operation MUST be failed with STATUS_ACCESS_DENIED.

- The object store MUST set **OutputBuffer.CreationTime** equal to **Open.File.CreationTime**.

- The object store MUST set **OutputBuffer.LastWriteTime** equal to **Open.File.LastModificationTime**.

- The object store MUST set **OutputBuffer.ChangeTime** equal to **Open.File.LastChangeTime**.

- The object store MUST set **OutputBuffer.LastAccessTime** equal to **Open.File.LastAccessTime**.

- If **Open.Stream.StreamType** is DirectoryStream:

  - The object store MUST set **OutputBuffer.FileAttributes** equal to the value of **Open.File.FileAttributes**.

  - The object store MUST set FILE_ATTRIBUTE_DIRECTORY in **OutputBuffer.FileAttributes**.

- Else:

  - This is a DataStream. The object store MUST set **OutputBuffer.FileAttributes** equal to the value of **Open.File.FileAttributes**. The following attribute values, if they are set in **Open.File.FileAttributes**, MUST NOT be copied to **OutputBuffer.FileAttributes** (attribute flags are defined in [MS-FSCC] section 2.6):

    - FILE_ATTRIBUTE_COMPRESSED

    - FILE_ATTRIBUTE_TEMPORARY

    - FILE_ATTRIBUTE_SPARSE_FILE

    - FILE_ATTRIBUTE_ENCRYPTED

  - If **Open.Stream.IsSparse** is TRUE, the object store MUST set FILE_ATTRIBUTE_SPARSE_FILE in **OutputBuffer.FileAttributes**.

  - If **Open.Stream.IsEncrypted** is TRUE, the object store MUST set FILE_ATTRIBUTE_ENCRYPTED in **OuputBuffer.FileAttributes**.

  - If **Open.Stream.IsTemporary** is TRUE, the object store MUST set FILE_ATTRIBUTE_TEMPORARY in **OutputBuffer.FileAttributes**.

  - If **Open.Stream.IsCompressed** is TRUE, the object store MUST set FILE_ATTRIBUTE_COMPRESSED in **OutputBuffer.FileAttributes**.

- EndIf

- If **OutputBuffer.FileAttributes** is 0, the object store MUST set FILE_ATTRIBUTE_NORMAL in **OutputBuffer.FileAttributes**.

- Upon successful completion of the operation, the object store MUST return:

  - **ByteCount** set to *sizeof(*FILE_BASIC_INFORMATION*)*.

  - **Status** set to STATUS_SUCCESS.

### 3.1.5.11.7 FileBothDirectoryInformation

This operation is not supported and MUST be failed with STATUS_ INVALID_INFO_CLASS.

### 3.1.5.11.8 FileCompressionInformation

**OutputBuffer** is of type FILE_COMPRESSION_INFORMATION as defined in [MS-FSCC] section 2.4.9.

Pseudocode for the operation is as follows:

- If **OutputBufferSize** is smaller than *sizeof(*FILE_COMPRESSION_INFORMATION*)*, the operation MUST be failed with STATUS_INFO_LENGTH_MISMATCH.

- The object store MUST initialize all fields in **OutputBuffer** to zero.

- If **Open.Stream.StreamType** is DirectoryStream:

  - If **Open.File.FileAttributes**.FILE_ATTRIBUTE_COMPRESSED is TRUE:

    - The object store MUST set **OutputBuffer.CompressionState** to COMPRESSION_FORMAT_LZNT1.

  - Else:

    - The object store MUST set **OutputBuffer.CompressionState** to COMPRESSION_FORMAT_NONE.

  - EndIf

- Else:

  - The object store MUST set **OutputBuffer.CompressedFileSize** to the number of bytes actually allocated on the underlying physical storage for storing the compressed data. This value MUST be a multiple of **Open.File.Volume.ClusterSize** and MUST be less than or equal to **Open.Stream.AllocationSize**.

  - If **Open.Stream.IsCompressed** is TRUE:

    - The object store MUST set **OutputBuffer.CompressionState** to COMPRESSION_FORMAT_LZNT1.

  - Else:

    - The object store MUST set **OutputBuffer.CompressionState** to COMPRESSION_FORMAT_NONE.

  - EndIf

- EndIf

- If **OutputBuffer.CompressionState** is not equal to COMPRESSION_FORMAT_NONE, the object store MUST set:

  - **OutputBuffer.CompressedUnitShift** to the base-2 logarithm of **Open.File.Volume.CompressionUnitSize**.

- **OutputBuffer.ChunkShift** to the base-2 logarithm of **Open.File.Volume.CompressedChunkSize**.

- **OutputBuffer.ClusterShift** to the base-2 logarithm of **Open.File.Volume.ClusterSize**.

- EndIf

- Upon successful completion of the operation, the object store MUST return:

    - **ByteCount** set to *sizeof(*FILE_COMPRESSION_INFORMATION*)*.

    - **Status** set to STATUS_SUCCESS.

### 3.1.5.11.9   FileDirectoryInformation

This operation is not supported and MUST be failed with STATUS_ INVALID_INFO_CLASS.

### 3.1.5.11.10   FileEaInformation

**OutputBuffer** is of type FILE_EA_INFORMATION as described in [MS-FSCC] 2.4.12.

Pseudocode for the operation is as follows:

- If **OutputBufferSize** is smaller than *sizeof(*FILE_EA_INFORMATION*)*, the operation MUST be failed with STATUS_INFO_LENGTH_MISMATCH.

- The object store MUST set:

    - **OutputBuffer.EaSize** set to **Open.File.ExtendedAttributesLength**. If **Open.File.ExtendedAttributesLength** is a nonzero value, **OutputBuffer.EaSize** is incremented by 4 to account for the header.

- Upon successful completion of the operation, the object store MUST return:

    - **ByteCount** set to *sizeof(*FILE_EA_INFORMATION*)*.

    - **Status** set to STATUS_SUCCESS.

### 3.1.5.11.11   FileFullDirectoryInformation

This operation is not supported and MUST be failed with STATUS_ INVALID_INFO_CLASS.

### 3.1.5.11.12   FileFullEaInformation

**OutputBuffer** is of type FILE_FULL_EA_INFORMATION as described in [MS-FSCC] 2.4.15.

Pseudocode for the operation is as follows:

- The object store MUST initialize **OutputBuffer** to zero.

- If **Open.GrantedAccess** does not contain FILE_READ_EA, the operation MUST be failed with STATUS_ACCESS_DENIED.

- If **Open.File.ExtendedAttributes** is not empty:

- **OutputBuffer** is filled with as many complete FILE_FULL_EA_INFORMATION entries from **Open.File.ExtendedAttributes,** starting with **Open.NextEaEntry,** as can be contained in **OutputBufferSize** bytes.

- **Open.NextEaEntry** is set to point to the entry after the last entry returned, if any.

- Endif

- Upon successful completion of the operation, the object store MUST return:

  - **ByteCount** set to the size, in bytes, of all FILE_FULL_EA_INFORMATION entries returned.

  - **Status** set to:

    - STATUS_NO_EAS_ON_FILE if there were no entries to return in **Open.File.ExtendedAttributes**.

    - STATUS_BUFFER_TOO_SMALL if **OutputBufferSize** is too small to hold **Open.NextEaEntry**. No entries are returned.

    - STATUS_BUFFER_OVERFLOW if at least one entry was returned in **OutputBuffer** but there are still additional entries to return.

    - STATUS_SUCCESS when one or more entries were returned from **Open.File.ExtendAttributes** and there are no more entries to return.

### 3.1.5.11.13   FileHardLinkInformation

This operation is not supported and MUST be failed with STATUS_NOT_SUPPORTED.

### 3.1.5.11.14   FileIdBothDirectoryInformation

This operation is not supported and MUST be failed with STATUS_ INVALID_INFO_CLASS.

### 3.1.5.11.15   FileIdFullDirectoryInformation

This operation is not supported and MUST be failed with STATUS_ INVALID_INFO_CLASS.

### 3.1.5.11.16   FileIdGlobalTxDirectoryInformation

This operation is not supported and MUST be failed with STATUS_ INVALID_INFO_CLASS.

### 3.1.5.11.17   FileInternalInformation

**OutputBuffer** is of type FILE_INTERNAL_INFORMATION as described in [MS-FSCC] 2.4.20.

Pseudocode for the operation is as follows:

- If **OutputBufferSize** is smaller than *sizeof(*FILE_INTERNAL_INFORMATION*)*, the operation MUST be failed with STATUS_INFO_LENGTH_MISMATCH.

- **OutputBuffer** MUST be filled out as follows:

  - **OutputBuffer.IndexNumber** set to **Open.File.FileID**.

- Upon successful completion of the operation, the object store MUST return:

- **ByteCount** set to *sizeof(*FILE_INTERNAL_INFORMATION*)*.

- **Status** set to STATUS_SUCCESS.

### 3.1.5.11.18  FileModeInformation

**OutputBuffer** is of type FILE_MODE_INFORMATION as described in [MS-FSCC] 2.4.24.

Pseudocode for the operation is as follows:

- If **OutputBufferSize** is smaller than *sizeof(*FILE_MODE_INFORMATION*)*, the operation MUST be failed with STATUS_INFO_LENGTH_MISMATCH.

- **OutputBuffer** MUST be filled out as follows:

  - **OutputBuffer.Mode** MUST be set to **Open.Mode**.

- Upon successful completion of the operation, the object store MUST return:

  - **ByteCount** set to *sizeof(*FILE_MODE_INFORMATION*)*.

  - **Status** set to STATUS_SUCCESS.

### 3.1.5.11.19  FileNameInformation

This operation is not supported and MUST be failed with STATUS_NOT_SUPPORTED.

### 3.1.5.11.20  FileNamesInformation

This operation is not supported as a file information class, it is only supported as a directory information class, as specified in section 3.1.5.5.3.6. If used to query file information STATUS_ INVALID_INFO_CLASS MUST be returned.

### 3.1.5.11.21  FileNetworkOpenInformation

**OutputBuffer** is of type FILE_NETWORK_OPEN_INFORMATION as defined in [MS-FSCC] section 2.4.27.

Pseudocode for the operation is as follows:

- If **OutputBufferSize** is smaller than *sizeof(*FILE_NETWORK_OPEN_INFORMATION*)*, the operation MUST be failed with STATUS_INFO_LENGTH_MISMATCH.

- If **Open.GrantedAccess** does not contain FILE_READ_ATTRIBUTES, the operation MUST be failed with STATUS_ACCESS_DENIED.

- **OutputBuffer** MUST be filled out as follows:

  - **OutputBuffer.CreationTime** set to **Open.File.CreationTime**.

  - **OutputBuffer.LastWriteTime** set to **Open.File.LastModificationTime**.

  - **OutputBuffer.ChangeTime** set to **Open.File.LastChangeTime.**

  - **OutputBuffer.LastAccessTime** set to **Open.File.LastAccessTime**.

  - **OutputBuffer.FileAttributes** set to **Open.File.FileAttributes**.

- If **Open.Stream.StreamType** is DirectoryStream:

  - FILE_ATTRIBUTE_DIRECTORY, as specified in [MS-FSCC] section 2.6, MUST always be set in **OutputBuffer.FileAttributes.**

- Else:

  - For a DataStream, the following attribute values, as specified in [MS-FSCC] section 2.6, MUST NOT be copied to **OutputBuffer.FileAttributes**:

    - FILE_ATTRIBUTE_COMPRESSED

    - FILE_ATTRIBUTE_TEMPORARY

    - FILE_ATTRIBUTE_SPARSE_FILE

    - FILE_ATTRIBUTE_ENCRYPTED

  - If **Open.Stream.IsSparse** is TRUE, the object store MUST set FILE_ATTRIBUTE_SPARSE_FILE in **OutputBuffer.FileAttributes**.

  - If **Open.Stream.IsEncrypted** is TRUE, set FILE_ATTRIBUTE_ENCRYPTED in **OuputBuffer.FileAttributes**.

  - If **Open.Stream.IsTemporary** is TRUE, set FILE_ATTRIBUTE_TEMPORARY in **OutputBuffer.FileAttributes**.

  - If **Open.Stream.IsCompressed** is TRUE, set FILE_ATTRIBUTE_COMPRESSED in **OutputBuffer.FileAttributes**.

  - **OutputBuffer.AllocationSize** set to **Open.Stream.AllocationSize**.

  - **OutputBuffer.EndOfFile** set to **Open.Stream.Size**.

- EndIf

  - If **OutputBuffer.FileAttributes** is 0, set FILE_ATTRIBUTE_NORMAL in **OutputBuffer.FileAttributes**.

- Upon successful completion of the operation, the object store MUST return:

  - **ByteCount** set to *sizeof(*FILE_NETWORK_OPEN_INFORMATION*)*.

  - **Status** set to STATUS_SUCCESS.

### 3.1.5.11.22   FileObjectIdInformation

This operation is not supported and MUST be failed with STATUS_NOT_SUPPORTED.

### 3.1.5.11.23   FilePositionInformation

**OutputBuffer** is of type FILE_POSITION_INFORMATION, as specified in [MS-FSCC] section 2.4.32.

Pseudocode for the operation is as follows:

- If **OutputBufferSize** is less than the size, in bytes, of the FILE_POSITION_INFORMATION structure, the operation MUST be failed with STATUS_INFO_LENGTH_MISMATCH.

- The objects store MUST set **OutputBuffer.CurrentByteOffset** equal to **Open.CurrentByteOffset**.

- The operation returns STATUS_SUCCESS.<57>

### 3.1.5.11.24   FileQuotaInformation

This operation is not supported as a file information class; it is only supported as a server request, as specified in section 3.1.5.20. If used to query file information STATUS_NOT_SUPPORTED MUST be returned.

### 3.1.5.11.25   FileReparsePointInformation

This operation is not supported as a file information class; it is only supported as a directory enumeration class, as specified in section 3.1.5.5.2. If used to query file information STATUS_NOT_SUPPORTED MUST be returned.

### 3.1.5.11.26   FileSfioReserveInformation

This operation is not supported and MUST be failed with STATUS_NOT_SUPPORTED.

### 3.1.5.11.27   FileStandardInformation

**OutputBuffer** is of type FILE_STANDARD_INFORMATION, as described in [MS-FSCC] 2.4.38.

Pseudocode for the operation is as follows:

- If **OutputBufferSize** is smaller than *sizeof(*FILE_STANDARD_INFORMATION*)*, the operation MUST be failed with STATUS_INFO_LENGTH_MISMATCH.

- **OutputBuffer** MUST be filled out as follows:

  - If **Open.Stream.StreamType** is DirectoryStream, set **OutputBuffer.Directory** to 1 else 0.

  - If **Open.Stream.StreamType** is DirectoryStream or **Open.Stream.Name** is empty:

    - If **Open.Link.IsDeleted** is TRUE, set **OutputBuffer.DeletePending** to 1 else 0.

  - Else:

    - If **Open.Stream.IsDeleted** is TRUE, set **OutputBuffer.DeletePending** to 1 else 0.

  - EndIf

    - **OutputBuffer.NumberOfLinks** set to the number of **Link** elements in **Open.File.LinkList**, except if **Link.IsDeleted** field is TRUE (that is, the number of not-deleted links to the file).<58>

    - If **OutputBuffer.NumberOfLinks** is 0, set **OutputBuffer.DeletePending** to 1.

    - **OutputBuffer.AllocationSize** set to **Open.Stream.AllocationSize**.

    - **OutputBuffer.EndOfFile** set to **Open.Stream.Size**.

- Upon successful completion of the operation, the object store MUST return:

  - **ByteCount** set to *sizeof(*FILE_STANDARD_INFORMATION*)*.

- **Status** set to STATUS_SUCCESS.

### 3.1.5.11.28   FileStandardLinkInformation

This operation is not supported and MUST be failed with STATUS_ INVALID_INFO_CLASS.

### 3.1.5.11.29   FileStreamInformation

**OutputBuffer** is of type FILE_STREAM_INFORMATION, as described in [MS-FSCC] 2.4.40.

This routine uses the following local variables:

- 32-bit unsigned integer: *StreamNameLength*, *RemainingLength*, *ThisElementSize*, *PreviousElementPadding*

- **Stream**: *ThisStream*

- Pointer to a buffer of type FILE_STREAM_INFORMATION: *CurrentPosition*, *LastPosition*

Pseudocode for the operation is as follows:

- Initialize *PreviousElementPadding* to 0.

- Initialize *CurrentPosition* to point to the 0th byte of **OutputBuffer**.

- Initialize *RemainingLength* to be equal to **OutputBufferSize**.

- For each **Stream** *ThisStream* of **Open.File**:

  - Set *StreamNameLength* equal to the length, in bytes, of *ThisStream*.**Name** plus the length, in bytes, of the Unicode string "$DATA" plus the length, in bytes, of two Unicode characters. This accommodates the length of the full stream name in the form :<*ThisStream*.**Name**>:$DATA.

  - Set *ThisElementSize* equal to the byte offset of *CurrentPosition*.**StreamName** plus *StreamNameLength*.

  - If *ThisElementSize* plus *PreviousElementPadding* is greater than *RemainingLength*, the operation MUST be failed with STATUS_BUFFER_OVERFLOW.

  - The object store MUST set *CurrentPosition*.**StreamSize** equal to *ThisStream*.**Size**.

  - The object store MUST set *CurrentPosition*.**AllocationSize** equal to *ThisStream*.**AllocationSize**.

  - The object store MUST set *CurrentPosition*.**StreamNameLength** equal to *StreamNameLength*.

  - The object store MUST set *CurrentPosition*.**StreamName** to the Unicode character ":", then append *ThisStream*.**Name**, then append the Unicode character ":", then append the Unicode string "$DATA".

  - Set *PreviousElementPadding* equal to **BlockAlign**(*ThisElementSize*, 8) minus *ThisElementSize*. The value *PreviousElementPadding* is used to align each FILE_STREAM_INFORMATION element in **OutputBuffer** on an 8-byte boundary.

  - The object store MUST set *CurrentPosition*.**NextEntryOffset** equal to *ThisElementSize* plus *PreviousElementPadding*.

- Set *RemainingLength* equal to *RemainingLength* minus (*ThisElementSize* plus *PreviousElementPadding*).

- Set *LastPosition* equal to *CurrentPosition*.

- Advance *CurrentPosition* by a number of bytes equal to *ThisElementSize* plus *PreviousElementPadding*.

- EndFor

- The object store MUST set *LastPosition*.**NextEntryOffset** equal to 0.

- The operation returns STATUS_SUCCESS.

### 3.1.5.12 Server Requests a Query of File System Information

The server provides:

- **Open:** An **Open** of a DataFile or DirectoryFile.

- **OutputBufferSize:** The maximum number of bytes to be returned in **OutputBuffer**.

- **FsInformationClass:** The type of information being queried, as specified in [MS-FSCC] section 2.5.

On completion, the object store MUST return:

- **Status:** An NTSTATUS code that specifies the result.

- **OutputBuffer:** An array of bytes containing the file system information. The structure of these bytes is dependent on **FsInformationClass**, as noted in the relevant subsection.

- **ByteCount:** The number of bytes stored in **OutputBuffer**.

Pseudocode for the operation is as follows:


If **FsInformationClass** is not defined in [MS-FSCC] section 2.5, the operation MUST be failed with STATUS_INVALID_PARAMETER.

### 3.1.5.12.1 FileFsVolumeInformation

**OutputBuffer** is of type FILE_FS_VOLUME_INFORMATION, as described in [MS-FSCC] 2.5.8.

This routine uses the following local variables:

- 32-bit unsigned integers: *RemainingLength*, *BytesToCopy*

Pseudocode for the operation is as follows:

- If **OutputBufferSize** is smaller than **BlockAlign(FieldOffset(**FILE_FS_VOLUME_INFORMATION.VolumeLabel**)**, 8**)**, the operation MUST be failed with STATUS_INFO_LENGTH_MISMATCH.

- **OutputBuffer** MUST be filled out as follows:

  - **OutputBuffer.VolumeCreationTime** set to **Open.File.Volume.VolumeCreationTime**.

- **OutputBuffer.VolumeSerialNumber** set to **Open.File.Volume.VolumeSerialNumber**.

- **OutputBuffer.VolumeLabelLength** set to the length, in bytes, of the **Open.File.Volume.VolumeLabel** string. This value can be zero.

- **OutputBuffer.SupportsObjects** set to TRUE.

- Set *RemainingLength* to **OutputBufferSize - FieldOffset(**FILE_FS_VOLUME_INFORMATION.VolumeLabel**)**.

- If *RemainingLength* < **OutputBuffer.VolumeLabelLength**:

  - Set *BytesToCopy* to *RemainingLength*.

- Else:

  - Set *BytesToCopy* to **OutputBuffer.VolumeLabelLength**.

- EndIf

- Copy *BytesToCopy* bytes from **Volume.VolumeLable** to **OutputBuffer.VolumeLabel**.

- Upon successful completion of the operation, the object store MUST return:

  - **ByteCount** set to **FieldOffset(**FILE_FS_VOLUME_INFORMATION.VolumeLabel**)** + *BytesToCopy*.

  - **Status** set to STATUS_BUFFER_OVERFLOW if *BytesToCopy* < **OutputBuffer.VolumeLabelLength** else STATUS_SUCCESS.

### 3.1.5.12.2   FileFsLabelInformation

This operation is not supported and MUST be failed with STATUS_NOT_SUPPORTED.

### 3.1.5.12.3   FileFsSizeInformation

**OutputBuffer** is of type FILE_FS_SIZE_INFORMATION as described in [MS-FSCC] 2.5.7.

This routine uses the following local variables:

- 64-bit unsigned integer: *RemainingQuota*

- FILE_QUOTA_INFORMATION element: *QuotaEntry*

Pseudocode for the operation is as follows:

- If **OutputBufferSize** is smaller than **sizeof(**FILE_FS_SIZE_INFORMATION**)**, the operation MUST be failed with STATUS_INFO_LENGTH_MISMATCH.

- **OutputBuffer** MUST be filled out as follows:

  - **OutputBuffer.TotalAllocationUnits** set to **Open.File.Volume.TotalSpace** / **Open.File.Volume.ClusterSize**.

  - **OutputBuffer.AvailableAllocationUnits** set to **Open.File.Volume.FreeSpace** / **Open.File.Volume.ClusterSize**.

- **OutputBuffer.SectorsPerAllocationUnit** set to **Open.File.Volume.ClusterSize** / **Open.File.Volume.SectorSize**.

- **OutputBuffer.BytesPerSector** set to **Open.File.Volume.SectorSize**.

- If **Open.File.Volume.QuotaInformation** contains an entry *QuotaEntry* that matches the SID of the current **Open**, the object store MUST modify the returned information based on *QuotaEntry* as follows:

  - If *QuotaEntry*.**QuotaLimit** < **Open.File.Volume.TotalSpace**:

    - **OutputBuffer.TotalAllocationUnits** MUST be set to *QuotaEntry*.**QuotaLimit /** **Open.File.Volume.ClusterSize**.

  - EndIf

  - If *QuotaEntry*.**QuotaLimit** <= *QuotaEntry*.**QuotaUsed**:

    - *RemainingQuota* MUST be set to 0.

  - Else

    - *RemainingQuota* MUST be set to *QuotaEntry*.**QuotaLimit** - *QuotaEntry*.**QuotaUsed**.

  - EndIf

  - If *RemainingQuota* < **Open.File.Volume.FreeSpace**:

    - **OutputBuffer.AvailableAllocationUnits** MUST be set to *RemainingQuota* / **Open.File.Volume.ClusterSize**.

  - EndIf

- EndIf

- Upon successful completion of the operation, the object store MUST return:

  - **ByteCount** MUST be set to *sizeof(*FILE_FS_SIZE_INFORMATION*)*.

  - **Status** set to STATUS_SUCCESS.

### 3.1.5.12.4   FileFsDeviceInformation

**OutputBuffer** is of type FILE_FS_DEVICE_INFORMATION, as described in [MS-FSCC] section 2.5.9.

Pseudocode for the operation is as follows:

- If **OutputBufferSize** is smaller than *sizeof(*FILE_FS_DEVICE_INFORMATION*)*, the operation MUST be failed with STATUS_INFO_LENGTH_MISMATCH .

- **OutputBuffer** MUST be filled out as follows:

  - **OutputBuffer.DeviceType** set to FILE_DEVICE_DISK or FILE_DEVICE_CD_ROM, as defined in [MS-FSCC] section 2.5.9, depending on the type of media that **Open.File.Volume** is mounted on.

  - **OutputBuffer.Characteristics** set to **Open.File.Volume.VolumeCharacteristics**.

- Upon successful completion of the operation, the object store MUST return:

- **ByteCount** set to *sizeof(*FILE_FS_DEVICE_INFORMATION*)*.

- **Status** set to STATUS_SUCCESS.

### 3.1.5.12.5   FileFsAttributeInformation

**OutputBuffer** is of type FILE_FS_ATTRIBUTE_INFORMATION, as described in [MS-FSCC] section 2.5.1.

This routine uses the following local variables:

- 32-bit unsigned integer: *RemainingLength*, *BytesToCopy*

Pseudocode for the operation is as follows:

- If **OutputBufferSize** is smaller than **BlockAlign(FieldOffset(**FILE_FS_ATTRIBUTE_INFORMATION.FileSystemName*)*, 4*)*, the operation MUST be failed with STATUS_INFO_LENGTH_MISMATCH.

- **OutputBuffer** MUST be filled out as follows:

  - **OutputBuffer.FileSystemAttributes** set to appropriate values, as specified in [MS-FSCC] section 2.5.1, based on the implementation of the given file system.<59>

  - **OutputBuffer.MaximumComponentNameLength** set to different values depending on the file system.<60>

  - **OutputBuffer.FileSystemNameLength** set to the length, in bytes, of the name of the file system on **Open.File.Volume**.

- Set *RemainingLength* to **OutputBufferSize - FieldOffset(**FILE_FS_ATTRIBUTE_INFORMATION.**FileSystemName***)*.

- If *RemainingLength* < **OutputBuffer.FileSystemNameLength**.

  - Set *BytesToCopy* to *RemainingLength*.

- Else

  - Set *BytesToCopy* to **OutputBuffer.FileSystemNameLength**.

- EndIf

- Copy *BytesToCopy* bytes from the file system name string to **OutputBuffer.FileSystemName**.

- Upon successful completion of the operation, the object store MUST return:

  - **ByteCount** set to *FieldOffset(*FILE_FS_ATTRIBUTE_INFORMATION.**FileSystemName***)+* *BytesToCopy*.

  - **Status** set to STATUS_BUFFER_OVERFLOW if *BytesToCopy* < **OutputBuffer.FileSystemNameLength** else STATUS_SUCCESS.

### 3.1.5.12.6   FileFsControlInformation

**OutputBuffer** is of type FILE_FS_CONTROL_INFORMATION, as described in [MS-FSCC] section 2.5.2.

Pseudocode for the operation is as follows:

- If **OutputBufferSize** is smaller than ***BlockAlign(sizeof(***FILE_FS_CONTROL_INFORMATION***)***, 8***)*** the operation MUST be failed with STATUS_INFO_LENGTH_MISMATCH.

- Support for this operation is optional. If the object store does not implement this functionality, the operation MUST be failed with STATUS_INVALID_PARAMETER.

- If **Open.File.Volume.IsQuotasSupported** is FALSE, the operation MUST be failed with STATUS_VOLUME_NOT_UPGRADED.

- The object store MUST initialize all fields in **OutputBuffer** to zero.

- If Quotas are supported on **Open.File.Volume**, the object store MUST set fields in **OutputBuffer** as follows:

  - **OutputBuffer**.**DefaultQuotaThreshold** set to **Open**.**File**.**Volume**.**DefaultQuotaThreshold**.

  - **OutputBuffer**.**DefaultQuotaLimit** set to **Open**.**File**.**Volume**.**DefaultQuotaLimit**.

  - **OutputBuffer**.**FileSystemControlFlags** set to **Open.File.Volume**.**VolumeQuotaState**.

- EndIf

- Upon successful completion of the operation, the object store MUST return:

  - **ByteCount** set to ***sizeof(***FILE_FS_CONTROL_INFORMATION***)***.

  - **Status** set to STATUS_SUCCESS.

### 3.1.5.12.7   FileFsFullSizeInformation

**OutputBuffer** is of type FILE_FS_FULL_SIZE_INFORMATION, as described in [MS-FSCC] 2.5.4.

This routine uses the following local variables:

- 64-bit unsigned integer: *RemainingQuota*

- FILE_QUOTA_INFORMATION element: *QuotaEntry*

Pseudocode for the operation is as follows:

- If **OutputBufferSize** is smaller than ***sizeof(***FILE_FS_FULL_SIZE_INFORMATION***)***, the operation MUST be failed with STATUS_INFO_LENGTH_MISMATCH.

- **OutputBuffer** MUST be filled out as follows:

  - **OutputBuffer.TotalAllocationUnits** set to **Open.File.Volume.TotalSpace** / **Open.File.Volume.ClusterSize**.

  - **OutputBuffer.CallerAvailableAllocationUnits** set to **Open.File.Volume.FreeSpace** / **Open.File.Volume.ClusterSize**.

  - **OutputBuffer.ActualAvailableAllocationUnits** set to **Open.File.Volume.FreeSpace** / **Open.File.Volume.ClusterSize**.

- ▪ **OutputBuffer.SectorsPerAllocationUnit** set to **Volume.ClusterSize** / **Open.File.Volume.SectorSize**.

- ▪ **OutputBuffer.BytesPerSector** set to **Open.File.Volume.SectorSize**.

- ▪ If **Open.File.Volume.QuotaInformation** contains an entry *QuotaEntry* that matches the SID of the current **Open**, the object store MUST modify the returned information based on *QuotaEntry* as follows:

  - ▪ If *QuotaEntry*.**QuotaLimit** < **Open.File.Volume.TotalSpace**:

    - ▪ **OutputBuffer.TotalAllocationUnits** MUST be set to *QuotaEntry*.**QuotaLimit /** **Open.File.Volume.ClusterSize**.

  - ▪ EndIf

  - ▪ If *QuotaEntry*.**QuotaLimit** <= *QuotaEntry*.**QuotaUsed:**

    - ▪ *RemainingQuota* MUST be set to 0.

  - ▪ Else

    - ▪ *RemainingQuota* MUST be set to *QuotaEntry*.**QuotaLimit** - *QuotaEntry*.**QuotaUsed**.

  - ▪ EndIf

  - ▪ If *RemainingQuota* < **Open.File.Volume.FreeSpace**:

    - ▪ **OutputBuffer.CallerAvailableAllocationUnits** MUST be set to *RemainingQuota* / **Open.File.Volume.ClusterSize**.

  - ▪ EndIf

- ▪ EndIf

- ▪ Upon successful completion of the operation, the object store MUST return:

  - ▪ **ByteCount** set to **sizeof(***FILE_FS_FULL_SIZE_INFORMATION***)**.

  - ▪ **Status** set to STATUS_SUCCESS.

### 3.1.5.12.8   FileFsObjectIdInformation

**OutputBuffer** is a FILE_FS_OBJECTID_INFORMATION structure as described in [MS-FSCC] section 2.5.6.

Pseudocode for the operation is as follows:

- ▪ If **OutputBufferSize** is less than **sizeof(**FILE_FS_OBJECTID_INFORMATION**)**, the operation MUST be failed with STATUS_INFO_LENGTH_MISMATCH.

- ▪ Support for ObjectIDs is optional. If the object store does not implement this functionality, the operation MUST be failed with STATUS_INVALID_PARAMETER.

- ▪ If **Open.File.Volume.IsObjectIDsSupported** is FALSE, the operation MUST be failed with STATUS_VOLUME_NOT_UPGRADED.

- If **Open.File.Volume.VolumeId** is empty, the operation MUST be failed with STATUS_OBJECT_NAME_NOT_FOUND.

- **OutputBuffer** MUST be filled out as follows:

  - **OutputBuffer.ObjectId** set to **Open.File.Volume.VolumeId**.

  - **OutputBuffer.ExtendedInfo** set to **Open.File.Volume.ExtendedInfo**.

- Upon successful completion of the operation, the object store MUST return:

  - **ByteCount** set to *sizeof(*FILE_FS_OBJECTID_INFORMATION*)*.

  - **Status** set to STATUS_SUCCESS.

### 3.1.5.12.9   FileFsDriverPathInformation

This operation is not supported and MUST be failed with STATUS_NOT_SUPPORTED.

### 3.1.5.13   Server Requests a Query of Security Information

The server provides:

- **Open:** The **Open** on which security information is being queried.

- **OutputBufferSize:** The maximum number of bytes to return in **OutputBuffer**.

- **SecurityInformation:** A SECURITY_INFORMATION data type, as defined in [MS-DTYP] section 2.4.7.

On completion, the object store MUST return:

- **Status:** An NTSTATUS code that specifies the result.

- **OutputBuffer:** An array of **OutputBufferSize** bytes formatted as a SECURITY_DESCRIPTOR structure in self-relative format, as described in [MS-DTYP] section 2.4.6.

- **ByteCount:** If the operation returns STATUS_SUCCESS, this will be set to the count of bytes filled into **OutputBuffer**. If the operation returns STATUS_BUFFER_OVERFLOW, this will be set to the required size, in bytes, of **OutputBuffer** so that the security descriptor will fit.

This routine uses the following local variables:

- A 32-bit unsigned integer used as a byte index into **OutputBuffer**: *NextFree*

- 32-bit unsigned integers: *SaclLength*, *MaclLength*

Pseudocode for the operation is as follows:

- Let *sizeof(*SECURITY_DESCRIPTOR_RELATIVE*)* equal the number of bytes occupied by the **Revision**, **Sbz1**, **Control**, **OffsetOwner**, **OffsetGroup**, **OffsetSacl**, and **OffsetDacl** fields of **OutputBuffer** (that is, the total size of those fields in a SECURITY_DESCRIPTOR in self-relative format, as described in [MS-DTYP] section 2.4.6).

- The operation MUST be failed with STATUS_ACCESS_DENIED under either of the following conditions:

- **SecurityInformation** contains any of OWNER_SECURITY_INFORMATION, GROUP_SECURITY_INFORMATION, LABEL_SECURITY_INFORMATION, or DACL_SECURITY_INFORMATION, and **Open.GrantedAccess** does not contain READ_CONTROL.

  - **SecurityInformation** contains SACL_SECURITY_INFORMATION and **Open.GrantedAccess** does not contain ACCESS_SYSTEM_SECURITY.

- If **Open.Stream.StreamType** is DataStream and **Open.Stream.Name** is not empty, the operation MUST be failed with STATUS_INVALID_PARAMETER; security information may only be queried on a file or directory handle, not on a stream handle.

- If **Open.File.SecurityDescriptor** is empty:

  - If **OutputBufferSize** is smaller than *sizeof(*SECURITY_DESCRIPTOR_RELATIVE*)*, the object store MUST set **ByteCount** equal to *sizeof(*SECURITY_DESCRIPTOR_RELATIVE*)*, and the operation MUST be failed with STATUS_BUFFER_OVERFLOW.

  - The object store MUST set **OutputBuffer.Revision** equal to 1; all other fields of **OutputBuffer** MUST be filled with NULL characters.

  - The object store MUST set the Self Relative (SR) bit in **OutputBuffer.Control**.

  - The operation returns STATUS_SUCCESS at this point.

- EndIf

- Set **ByteCount** equal to *sizeof(*SECURITY_DESCRIPTOR_RELATIVE*)*.

- If **SecurityInformation** contains OWNER_SECURITY_INFORMATION and **Open.File.SecurityDescriptor.Owner** is not NULL:

  - **ByteCount** += *BlockAlign*(**SidLength**(**Open.File.SecurityDescriptor.Owner**), 4)

- EndIf

- If **SecurityInformation** contains GROUP_SECURITY_INFORMATION and **Open.File.SecurityDescriptor.Group** is not NULL:

  - **ByteCount** += *BlockAlign*(**SidLength** (**Open.File.SecurityDescriptor.Group**), 4)

- EndIf

- If **SecurityInformation** contains DACL_SECURITY_INFORMATION and the DACL Present (DP) bit is set in **Open.File.SecurityDescriptor.Control** and **Open.File.SecurityDescriptor.Dacl** is not NULL:

  - **ByteCount** += *BlockAlign*(**SidLength**(**Open.File.SecurityDescriptor.Dacl.AclSize**), 4)

- EndIf

- If **SecurityInformation** contains SACL_SECURITY_INFORMATION|LABEL_SECURITY_INFORMATION and the SACL Present (SP) bit is set in **Open.File.SecurityDescriptor.Control** and

  - **Open.File.SecurityDescriptor.Sacl** is not NULL:

  - *SaclLength* = *BlockAlign*(**SidLength**(**Open.File.SecurityDescriptor.Sacl.AclSize**), 4)

- **ByteCount** += *SaclLength*

- Else

  - If **SecurityInformation** contains SACL_SECURITY_INFORMATION and the SACL Present (SP) bit is set in **Open.File.SecurityDescriptor.Control** and **Open.File.SecurityDescriptor.Sacl** is not NULL:

    - *SaclLength* = **BlockAlign**(**SidLength**(**Open.File.SecurityDescriptor.Sacl.AclSize**), 4)

    - For each access control entry (ACE) (as defined in [MS-DTYP] section 2.4.4) in **Open.File.SecurityDescriptor.Sacl** whose **AceType** field is SYSTEM_MANDATORY_LABEL_ACE_TYPE:

      - *SaclLength* -= this ACE's **AceSize** field

    - EndFor

    - **ByteCount** += *SaclLength*

  - EndIf

  - If **SecurityInformation** contains LABEL_SECURITY_INFORMATION and the SACL Present (SP) bit is set in **Open.File.SecurityDescriptor.Control** and **Open.File.SecurityDescriptor.Sacl** is not NULL:

    - *MaclLength* = **BlockAlign**( (size of ACL as defined in [MS-DTYP] section 2.4.5), 4)

    - For each ACE (as defined in [MS-DTYP] section 2.4.4) in **Open.File.SecurityDescriptor.Sacl** whose **AceType** field is SYSTEM_MANDATORY_LABEL_ACE_TYPE:

      - *MaclLength* += this ACE's **AceSize** field

    - EndFor

    - **ByteCount** += *MaclLength*

  - EndIf

- EndIf

- If **ByteCount** is greater than **OutputBufferSize**, the operation MUST be failed with STATUS_BUFFER_OVERFLOW.

- The object store MUST set **OutputBuffer.Revision** equal to 1; all other fields of **OutputBuffer** MUST be filled with NULL characters.

- The object store MUST set the Self Relative (SR) bit in **OutputBuffer.Control**.

- Set *NextFree* to **sizeof(**SECURITY_DESCRIPTOR_RELATIVE**)** (that is, to the offset of **OutputBuffer.OwnerSid**).

- If **SecurityInformation** contains OWNER_SECURITY_INFORMATION and **Open.File.SecurityDescriptor.Owner** is not NULL:

  - The object store MUST copy **SidLength**(**Open.File.SecurityDescriptor.Owner**) bytes from **Open.File.SecurityDescriptor.Owner** to **OutputBuffer** at the position of *NextFree*.

- ▪ The object store MUST set **OutputBuffer.OffsetOwner** equal to *NextFree*.

- ▪ The object store MUST set the state of the Owner Defaulted (OD) bit of **OutputBuffer.Control** equal to the state of the same bit in **Open.File.SecurityDescriptor.Control**.

- ▪ *NextFree += BlockAlign(SidLength(Open.File.SecurityDescriptor.Owner), 4)*.

- ▪ EndIf

- ▪ If **SecurityInformation** contains GROUP_SECURITY_INFORMATION and **Open.File.SecurityDescriptor.Group** is not NULL:

  - ▪ The object store MUST copy *SidLength*(**Open.File.SecurityDescriptor.Group**) bytes from **Open.File.SecurityDescriptor.Group** to **OutputBuffer** at the position of *NextFree*.

  - ▪ The object store MUST set **OutputBuffer.OffsetGroup** equal to *NextFree*.

  - ▪ The object store MUST set the state of the Group Defaulted (GD) bit of **OutputBuffer.Control** equal to the state of the same bit in **Open.File.SecurityDescriptor.Control**.

  - ▪ *NextFree += BlockAlign(SidLength(Open.File.SecurityDescriptor.Group), 4)*.

- ▪ EndIf

- ▪ If **SecurityInformation** contains DACL_SECURITY_INFORMATION:

  - ▪ The object store MUST set the state of the DACL Present (DP), DACL Defaulted (DD), DACL Protected (PD), and DACL Auto-Inherited (DI) bits of **OutputBuffer.Control** equal to the state of the same bits in **Open.File.SecurityDescriptor.Control**.

  - ▪ If the DACL Present (DP) bit is set in **Open.File.SecurityDescriptor.Control** and **Open.File.SecurityDescriptor.Dacl** is not NULL:

    - ▪ The object store MUST copy **Open.File.SecurityDescriptor.Dacl.AclSize** bytes from **Open.File.SecurityDescriptor.Dacl** to **OutputBuffer** at the position of *NextFree*.

    - ▪ The object store MUST set **OutputBuffer.OffsetDacl** equal to *NextFree*.

    - ▪ *NextFree += BlockAlign(Open.File.SecurityDescriptor.Dacl.AclSize, 4)*.

  - ▪ EndIf

- ▪ EndIf

- ▪ If **SecurityInformation** contains SACL_SECURITY_INFORMATION|LABEL_SECURITY_INFORMATION:

  - ▪ The object store MUST set the state of the SACL Present (SP), SACL Defaulted (SD), SACL Protected (PS), and SACL Auto-Inherited (SI) bits of **OutputBuffer.Control** equal to the state of the same bits in **Open.File.SecurityDescriptor.Control**.

  - ▪ If the SACL Present (SP) bit is set in **Open.File.SecurityDescriptor.Control** and **Open.File.SecurityDescriptor.Sacl** is not NULL:

    - ▪ The object store MUST copy **Open.File.SecurityDescriptor.Sacl.AclSize** bytes from **Open.File.SecurityDescriptor.Sacl** to **OutputBuffer** at the position of *NextFree*.

- The object store MUST set **OutputBuffer.OffsetSacl** equal to *NextFree.*

- *NextFree += SaclLength*.

- EndIf

- Else

  - If **SecurityInformation** contains SACL_SECURITY_INFORMATION:

  - The object store MUST set the state of the SACL Present (SP), SACL Defaulted (SD), SACL Protected (PS), and SACL Auto-Inherited (SI) bits of **OutputBuffer.Control** equal to the state of the same bits in **Open.File.SecurityDescriptor.Control**.

  - If the SACL Present (SP) bit is set in **Open.File.SecurityDescriptor.Control** and **Open.File.SecurityDescriptor.Sacl** is not NULL:

    - Perform an ACE copy according to the algorithm in section 3.1.5.13.1, setting the ACE copy algorithm's parameters as follows:

      - **DestSacl** equal to the position in **OutputBuffer** of *NextFree*.

      - **SrcSacl** equal to **Open.File.SecurityDescriptor.Sacl**.

      - **CopyAudit** set to TRUE.

    - The object store MUST set **OutputBuffer.OffsetSacl** equal to *NextFree*.

    - *NextFree += SaclLength*.

  - EndIf

  - Else If **SecurityInformation** contains LABEL_SECURITY_INFORMATION:

  - The object store MUST set the state of the SACL Present (SP), SACL Defaulted (SD), SACL Protected (PS), and SACL Auto-Inherited (SI) bits of **OutputBuffer.Control** equal to the state of the same bits in **Open.File.SecurityDescriptor.Control**.

  - If the SACL Present (SP) bit is set in **Open.File.SecurityDescriptor.Control** and **Open.File.SecurityDescriptor.Sacl** is not NULL:

    - Perform an ACE copy according to the algorithm in section 3.1.5.13.1, setting the ACE copy algorithm's parameters as follows:

      - **DestSacl** equal to the position in **OutputBuffer** of *NextFree*.

      - **SrcSacl** equal to **Open.File.SecurityDescriptor.Sacl**.

      - **CopyAudit** set to FALSE.

    - The object store MUST set **OutputBuffer.OffsetSacl** equal to *NextFree*.

    - *NextFree += MaclLength*.

  - EndIf

  - EndIf

- EndIf

*Release: Friday, February 4, 2011*

- The operation returns STATUS_SUCCESS.

### 3.1.5.13.1  Algorithm for Copying Audit or Label ACEs Into a Buffer

The inputs for an ACE copy are:

- **DestSacl:** A destination buffer formatted as an access control list (ACL), as defined in [MS-DTYP] section 2.4.5.

- **SrcSacl:** A source buffer formatted as an ACL, as defined in [MS-DTYP] section 2.4.5.

- **CopyAudit:** A Boolean value. If TRUE, this algorithm copies only ACEs whose **AceType** field is not SYSTEM_MANDATORY_LABEL_ACE_TYPE. If FALSE, this algorithm copies only ACEs whose **AceType** field is SYSTEM_MANDATORY_LABEL_ACE_TYPE.

The ACE copy algorithm uses the following local variables:

- ACE (as defined in [MS-DTYP] section 2.4.4): *ThisAce*

- Byte pointer: *NextFree*

Pseudocode for the algorithm is as follows:

- Copy (size of ACL as defined in [MS-DTYP] section 2.4.5) bytes from **SrcSacl** to **DestSacl**.

- Set **DestSacl.AceCount** to 0.

- Set **DestSacl.AclSize** to (size of ACL as defined in [MS-DTYP] section 2.4.5).

- Set *NextFree* to (size of ACL as defined in [MS-DTYP] section 2.4.5) bytes from the beginning of **DestSacl**.

- For each ACE *ThisAce* in **SrcSacl**:

  - If ((**CopyAudit** is TRUE and *ThisAce*.**AceType** is not SYSTEM_MANDATORY_LABEL_ACE_TYPE) or (**CopyAudit** is FALSE and *ThisAce*.**AceType** is SYSTEM_MANDATORY_LABEL_ACE_TYPE)):

    - Copy *ThisAce*.**AceSize** bytes from *ThisAce* to *NextFree*.

    - **DestSacl.AceCount** += 1

    - **DestSacl.AclSize** = **DestSacl.AclSize** + *ThisAce*.**AceSize**

    - Advance *NextFree* by *ThisAce*.**AceSize** bytes.

  - EndIf

- EndFor

### 3.1.5.14  Server Requests Setting of File Information

The server provides:

- **Open:** An **Open** of a DataFile or DirectoryFile.

- **FileInformationClass:** The type of information being applied, as specified in [MS-FSCC] section 2.4.

- **InputBuffer:** A buffer that contains the information to be applied to the object.

- **InputBufferSize:** The size of the buffer provided.

The object store MUST return:

- **Status:** An NTSTATUS code indicating the result of the operation.

Pseudocode for the operation is as follows:

- If **Open.File.Volume.IsReadOnly** is TRUE, the operation MUST be failed with STATUS_MEDIA_WRITE_PROTECTED.

### 3.1.5.14.1   FileAllocationInformation

**InputBuffer** is of type FILE_ALLOCATION_INFORMATION as described in [MS-FSCC] section 2.4.4.

This operation MUST be failed with STATUS_INVALID_PARAMETER under any of the following conditions:

- If **Open.Stream.StreamType** is DirectoryStream.

- If **InputBuffer.AllocationSize** is greater than the maximum file size allowed by the object store.<61>

Pseudocode for the operation is as follows:

- If **Open.GrantedAccess** does not contain FILE_WRITE_DATA, the operation MUST be failed with STATUS_ACCESS_DENIED.

- If **Open.Stream.Oplock** is not empty, the object store MUST check for an oplock break according to the algorithm in section 3.1.4.12, with input values as follows:

    - **Open** equal to this operation's **Open**

    - **Operation** equal to "SET_INFORMATION"

    - **OpParams** containing a member **FileInformationClass** containing **FileAllocationInformation**

- If **Open.Stream.IsDeleted** is TRUE, the operation SHOULD return STATUS_SUCCESS.

- Set *NewAllocationSize* to **BlockAlign**(**InputBuffer.AllocationSize**,**Open.File.Volume.ClusterSize**) as described in section 3.1.4.5.

- If **Open.Stream.AllocationSize** is equal to *NewAllocationSize*, the operation MUST return STATUS_SUCCESS.

- If the space for *NewAllocationSize* cannot be reserved in the storage media, then the operation MUST be failed with STATUS_DISK_FULL.

- **Open.Stream.AllocationSize** MUST be set to *NewAllocationSize*.

- If *NewAllocationSize* is less than **Open.Stream.Size**:

    - The object store MUST set **Open.Stream.Size** to *NewAllocationSize*, truncating the Stream.

- The object store MUST post a USN change as per section 3.1.4.11 with **File** equal to **File**, **Reason** equal to USN_REASON_DATA_TRUNCATION, and **FileName** equal to **Open.Link.Name**.

- EndIf

- If **Open.Stream.ValidDataLength** is greater than **Open.Stream.Size**, then the object store MUST set **Open.Stream.ValidDataLength** to **Open.Stream.Size**.

- The operation returns STATUS_SUCCESS.

### 3.1.5.14.2   FileBasicInformation

**InputBuffer** is of type FILE_BASIC_INFORMATION as described in [MS-FSCC] section 2.4.7.

Pseudocode for the operation is as follows:

- If **InputBufferSize** is less than **sizeof(**FILE_BASIC_INFORMATION**)**, the operation MUST be failed with STATUS_INFO_LENGTH_MISMATCH.

- The operation MUST be failed with STATUS_INVALID_PARAMETER under any of the following conditions:

  - If **InputBuffer.CreationTime** is less than -1.

  - If **InputBuffer.LastAccessTime** is less than -1.

  - If **InputBuffer.LastWriteTime** is less than -1.

  - If **InputBuffer.ChangeTime** is less than -1.

  - If **InputBuffer.FileAttributes**.FILE_ATTRIBUTE_DIRECTORY is TRUE and **Open.Stream.StreamType** is DataStream.

  - If **InputBuffer.FileAttributes**.FILE_ATTRIBUTE_TEMPORARY is TRUE and **Open.File.FileType** is DirectoryFile.

- The object store MUST initialize local variables as follows:

  - *CurrentTime* to the current system time.

  - *OriginalFileAttributes* to **Open.File.FileAttributes**.

  - *UsnReason* to 0.

  - *ValidSetAttributes* to (FILE_ATTRIBUTE_READONLY | FILE_ATTRIBUTE_HIDDEN | FILE_ATTRIBUTE_SYSTEM | FILE_ATTRIBUTE_ARCHIVE | FILE_ATTRIBUTE_TEMPORARY | FILE_ATTRIBUTE_OFFLINE | FILE_ATTRIBUTE_NOT_CONTENT_INDEXED)

- If **InputBuffer.FileAttributes** != 0:

  - If **Open.File** is equal to **Open.File.Volume.RootDirectory**, the object store MUST NOT allow the application to change the hidden or system attributes:

    - *ValidSetAttributes* &= ~(FILE_ATTRIBUTE_HIDDEN | FILE_ATTRIBUTE_SYSTEM)

  - EndIf

- Open.File.FileAttributes &= ~*ValidSetAttributes*

- Open.File.FileAttributes |= (InputBuffer.FileAttributes & *ValidSetAttributes*)

- The object store MUST set **Open.File.PendingNotifications.**FILE_NOTIFY_CHANGE_ATTRIBUTES to TRUE.

- If **InputBuffer.FileAttributes**.FILE_ATTRIBUTE_TEMPORARY is TRUE, the object store MUST set **Open.Stream.IsTemporary** to TRUE; otherwise it MUST be set to FALSE.

- If **Open.UserSetChangeTime** is FALSE and **InputBuffer.ChangeTime** != -1, the object store MUST set **Open.File.LastChangeTime** to *CurrentTime*.

- If **Open.File.FileAttributes** is not equal to *OriginalFileAttributes*, the object store MUST set *UsnReason*.USN_REASON_BASIC_INFO_CHANGE to TRUE.

- If **Open.File.FileAttributes.** FILE_ATTRIBUTE_NOT_CONTENT_INDEXED is not equal to *OriginalFileAttributes*.FILE_ATTRIBUTE_NOT_CONTENT_INDEXED, the object store MUST set *UsnReason*.USN_REASON_INDEXABLE_CHANGE to TRUE.

- EndIf

- If **InputBuffer.ChangeTime** != 0:

  - The object store MUST set **Open.UserSetChangeTime** to TRUE.

  - If **InputBuffer.ChangeTime** != -1:

    - If **InputBuffer.ChangeTime** !=**Open.File.LastChangeTime**, the object store MUST set *UsnReason*.USN_REASON_BASIC_INFO_CHANGE to TRUE.

    - The object store MUST set **Open.File.LastChangeTime** to **InputBuffer.ChangeTime**.

  - EndIf

- EndIf

- If **InputBuffer.CreationTime** != 0 and **InputBuffer.CreationTime** != -1:

  - If **InputBuffer.CreationTime** != **Open.File.CreationTime**, the object store MUST set *UsnReason*.USN_REASON_BASIC_INFO_CHANGE to TRUE.

  - The object store MUST set **Open.File.CreationTime** to **InputBuffer.CreationTime**.

  - The object store MUST set **Open.File.PendingNotifications.**FILE_NOTIFY_CHANGE_CREATION to TRUE.

  - If **Open.UserSetChangeTime** is FALSE and **InputBuffer.ChangeTime** != -1, the object store MUST set **Open.File.LastChangeTime** to *CurrentTime*.

- EndIf

- If **InputBuffer.LastAccessTime** != 0:

  - The object store MUST set **Open.UserSetAccessTime** to TRUE.

  - If **InputBuffer.LastAccessTime** != -1:

- If **InputBuffer. LastAccessTime** != **Open.File.LastAccessTime**, the object store MUST set *UsnReason*.USN_REASON_BASIC_INFO_CHANGE to TRUE.

- The object store MUST set **Open.File.LastAccessTime** to **InputBuffer. LastAccessTime**.

- The object store MUST set **Open.File.PendingNotifications.**FILE_NOTIFY_CHANGE_LAST_ACCESS to TRUE.

- If **Open.UserSetChangeTime** is FALSE and **InputBuffer.ChangeTime** != -1, the object store MUST set **Open.File.LastChangeTime** to *CurrentTime*.

- EndIf

- EndIf

- If **InputBuffer.LastWriteTime** != 0:

    - The object store MUST set **Open.UserSetModificationTime** to TRUE.

    - If **InputBuffer.LastWriteTime** != -1:

        - If **InputBuffer. LastWriteTime** != **Open.File.LastModificationTime**, the object store MUST set *UsnReason*.USN_REASON_BASIC_INFO_CHANGE to TRUE.

        - The object store MUST set **Open.File.LastModificationTime** to **InputBuffer. LastWriteTime**.

        - The object store MUST set **Open.File.PendingNotifications.**FILE_NOTIFY_CHANGE_LAST_WRITE to TRUE.

        - If **Open.UserSetChangeTime** is FALSE and **InputBuffer.ChangeTime** != -1, the object store MUST set **Open.File.LastChangeTime** to *CurrentTime*.

    - EndIf

- EndIf

- The object store MUST post a USN change as per section [3.1.4.11](#) with **File** equal to **File**, **Reason** equal to *UsnReason*, and **FileName** equal to **Open.Link.Name**.

- The operation returns STATUS_SUCCESS.

### 3.1.5.14.3  FileDispositionInformation

**InputBuffer** is of type FILE_DISPOSITION_INFORMATION as described in [MS-FSCC] section 2.4.11.

Pseudocode for the operation is as follows:

- If **Open.GrantedAccess** does not contain DELETE, the operation MUST be failed with STATUS_ACCESS_DENIED.

- If **InputBuffer.DeletePending** is TRUE:

    - If **File.FileAttributes.FILE_ATTRIBUTE_READONLY** is TRUE, the operation MUST be failed with STATUS_CANNOT_DELETE.

- If **Open.Stream.Name** is empty:

  - If **Open.Stream.StreamType** is DirectoryStream and **Open.File.DirectoryList** is not empty, the operation MUST be failed with STATUS_DIRECTORY_NOT_EMPTY.

  - Set **Open.Link.IsDeleted** to TRUE.

  - If **Open.Stream.StreamType** is DirectoryStream:

    - For each *ChangeNotifyEntry* in **Volume.ChangeNotifyList** where *ChangeNotifyEntry* **.OpenedDirectory.File** is equal to **Open.File** then the following actions MUST be taken:

      - Remove *ChangeNotifyEntry* from **Volume.ChangeNotifyList**.

      - Complete the **ChangeNotify** operation with status STATUS_DELETE_PENDING.

    - EndFor

  - EndIf

  - Else:

    - Set **Open.Stream.IsDeleted** to TRUE.

  - EndIf

- Else:

  - If **Open.Stream.Name** is empty:

    - **Set Open.Link.IsDeleted** to FALSE.

  - Else:

    - **Set Open.Stream.IsDeleted** to FALSE.

  - EndIf

- EndIf

- The operation returns STATUS_SUCCESS.

### 3.1.5.14.4   FileEndOfFileInformation

**InputBuffer** is of type FILE_END_OF_FILE_INFORMATION as described in [MS-FSCC] section 2.4.13.

Pseudocode for the operation is as follows:

- The operation MUST be failed with STATUS_INVALID_PARAMETER under any of the following conditions:

  - If **Open.Stream.StreamType** is DirectoryStream.

  - If **InputBuffer.EndOfFile** is greater than the maximum file size allowed by the object store.<62>

- If **Open.GrantedAccess** does not contain FILE_WRITE_DATA, the operation MUST be failed with STATUS_ACCESS_DENIED.

- If **Open.Stream.Oplock** is not empty, the object store MUST check for an oplock break according to the algorithm in section 3.1.4.12, with input values as follows:

  - **Open** equal to this operation's **Open**

  - **Operation** equal to "SET_INFORMATION"

  - **OpParams** containing a member **FileInformationClass** containing **FileEndOfFileInformation**

- If **Open.Stream.IsDeleted** is TRUE, the operation SHOULD return STATUS_SUCCESS.

- If **Open.Stream.Size** is equal to **InputBuffer.EndOfFile**, the operation MUST return STATUS_SUCCESS at this point.

- If **InputBuffer.EndOfFile** is greater than **Open.Stream.Size:**

  - The object store MUST post a USN change as per section 3.1.4.11 with **File** equal to **File**, **Reason** equal to USN_REASON_DATA_EXTEND, and **FileName** equal to **Open.Link.Name**.

- Else:

  - The object store MUST post a USN change as per section 3.1.4.11 with **File** equal to **File**, **Reason** equal to USN_REASON_DATA_TRUNCATION, and **FileName** equal to **Open.Link.Name**.

- EndIf

- If **InputBuffer.EndOfFile** is greater than **Open.Stream.AllocationSize**, the object store MUST set **Open.Stream.AllocationSize** to *BlockAlign*(**InputBuffer.EndOfFile**, **Open.File.Volume.ClusterSize***)*. If the space cannot be reserved, then the operation MUST be failed with STATUS_DISK_FULL.

- If **InputBuffer.EndOfFile** is less than (*BlockAlign*(**Open.Stream.Size**, **Open.File.Volume.ClusterSize**) -**Open.File.Volume.ClusterSize**), the object store SHOULD set **Open.Stream.AllocationSize** to BlockAlign (**InputBuffer.EndOfFile**, **Open.File.Volume.ClusterSize**).

- If **Open.Stream.ValidDataLength** is greater than **InputBuffer.EndOfFile**, the object store MUST set **Open.Stream.ValidDataLength** to **InputBuffer.EndOfFile**.

- The object store MUST set **Open.Stream.Size** to **InputBuffer.EndOfFile**.

- The operation returns STATUS_SUCCESS.

### 3.1.5.14.5   FileFullEaInformation

**InputBuffer** is of type FILE_FULL_EA_INFORMATION, as described in [MS-FSCC] section 2.4.15.

Pseudocode for the operation is as follows:

- If **Open.File.FileAttributes.FILE_ATTRIBUTE_REPARSE_POINT** is TRUE, the object store MUST fail the operation with STATUS_EAS_NOT_SUPPORTED.

- For each *Ea* in **InputBuffer**:

- If *Ea*.**EaName** is not well-formed as per [MS-FSCC] 2.4.15, the operation MUST be failed with STATUS_INVALID_EA_NAME.

- If *Ea*.**Flags** does not contain a valid set of flags as per [MS-FSCC] 2.4.15, the operation MUST be failed with STATUS_INVALID_EA_NAME.

- If *Ea*.**EaName** exists in the **Open.File.ExtendedAttributes,** remove that entry from **Open.File.ExtendedAttributes**, updating **Open.File.ExtendedAttributesLength** to reflect the new list size.

- If *Ea*.**EaValueLength** is NOT zero, add *Ea* to **Open.File.ExtendedAttributes**, updating **Open.File.ExtendedAttributesLength** to reflect the new list size

- If **Open.File.ExtendedAttributesLength** becomes greater than 64 KB - 5 bytes, the object store MUST fail the operation with STATUS_EA_TOO_LARGE and undo any changes made as part of this operation.

- EndFor

- The object store MUST set **Open.File.FileAttributes.FILE_ATTRIBUTE_ARCHIVE** to TRUE.

- The object store MUST post a USN change as per section 3.1.4.11 with **File** equal to **File**, **Reason** equal to USN_REASON_EA_CHANGE, and **FileName** equal to **Open.Link.Name**.

- Set **Open.File.PendingNotifications.**FILE_NOTIFY_CHANGE_EA to TRUE and **Open.File.PendingNotifications.**FILE_NOTIFY_CHANGE_ATTRIBUTES to TRUE.

### 3.1.5.14.6   FileLinkInformation

**InputBuffer** is of type FILE_RENAME_INFORMATION, as described in [MS-FSCC] section 2.4.34.2.

**Open** represents the pre-existing file to which a new link named in **InputBuffer.FileName** will be created.

Pseudocode for the operation is as follows:

- If **Open.Stream.StreamType** is DataStream and **Open.Stream.Name** is not empty, the operation MUST be failed with STATUS_INVALID_PARAMETER.

- If **Open.File.FileType** is DirectoryFile, the operation MUST be failed with STATUS_FILE_IS_A_DIRECTORY.

- If **Open.Link.IsDeleted** is TRUE, the operation MUST be failed with STATUS_ACCESS_DENIED.

- If **InputBuffer.FileName** is not valid as specified in [MS-FSCC] section 2.1.5, the operation MUST be failed with STATUS_OBJECT_NAME_INVALID.

- If **Open.File.LinkList** has 1024 or more entries, the operation SHOULD be failed with STATUS_TOO_MANY_LINKS.

- Split **InputBuffer.FileName** into *PathName* and *FileName*, as per section 3.1.5.1.

- Open *DestinationDirectory* from *PathName*, as per section 3.1.5.1. If the open fails for any reason, the object store MUST fail the request with that error. This request requires that the caller has FILE_ADD_FILE access on the *DestinationDirectory* -- if not, the store MUST fail with STATUS_ACCESS_DENIED.

- Search *DestinationDirectory*.**File.DirectoryList** for an *ExistingLink* where *ExistingLink*.**Name** or *ExistingLink*.**ShortName** matches *FileName* using case-sensitivity according to **Open.IsCaseInsensitive**. If such a link is found:

  - If **InputBuffer.ReplaceIfExists** is TRUE:

    - Set *ReplacedLinkName* = *DestinationDirectory*.**FileName +** *FileName*.

    - Remove *ExistingLink* from *ExistingLink*.**File.LinkList**.

    - Remove *ExistingLink* from *DestinationDirectory*.**File.DirectoryList**.

    - Set *DeletedLink* to TRUE.

  - Else:

    - The operation MUST be failed with STATUS_OBJECT_NAME_COLLISION.

  - EndIf

- EndIf

- The object store MUST build a new Link object *NewLink* with fields initialized as follows:

  - *NewLink*.**Name** set to *FileName*.

  - *NewLink*.**File** set to **Open.File**.

  - *NewLink*.**ParentFile** set to *DestinationDirectory*.**File**.

  - All other fields set to zero.

- The object store MUST insert *NewLink* into **Open.File.LinkList**

- The object store MUST insert *NewLink* into *DestinationDirectory*.**File.DirectoryList**.

- The object store MUST update *DestinationDirectory*.**File.LastModifiedTime**, *DestinationDirectory*.**File.LastAccessedTime**, and *DestinationDirectory*.**File.LastChangeTime**.

- If *DeletedLink* is TRUE:

  - If *ReplacedLinkName* equals **InputBuffer.FileName** in a case-sensitive comparison:

    - // In this case, the link name has not changed, but the file it refers to has changed.

    - *Action* = FILE_ACTION_MODIFIED

    - *FilterMatch* = FILE_NOTIFY_CHANGE_ATTRIBUTES | FILE_NOTIFY_CHANGE_SIZE | FILE_NOTIFY_CHANGE_LAST_WRITE | FILE_NOTIFY_CHANGE_LAST_ACCESS | FILE_NOTIFY_CHANGE_CREATION | FILE_NOTIFY_CHANGE_SECURITY | FILE_NOTIFY_CHANGE_EA

    - Send directory change notification as per section 3.1.4.1, with **Volume** equal to **File.Volume**, **Action** equal to *Action*, **FilterMatch** equal to *FilterMatch*, and **FileName** equal to **InputBuffer.FileName**.

  - Else

- // In this case, the implementer replaced a link, but the new link created differs only in case.

- *Action* = FILE_ACTION_REMOVED

- *FilterMatch* = FILE_NOTIFY_CHANGE_FILE_NAME

- Send directory change notification as per section 3.1.4.1, with **Volume** equal to **File.Volume**, **Action** equal to *Action*, **FilterMatch** equal to *FilterMatch*, and **FileName** equal to **InputBuffer.FileName**.

- *Action* = FILE_ACTION_ADDED

- *FilterMatch* = FILE_NOTIFY_CHANGE_FILE_NAME

- Send directory change notification as per section 3.1.4.1, with **Volume** equal to **File.Volume**, **Action** equal to *Action*, **FilterMatch** equal to *FilterMatch*, and **FileName** equal to **InputBuffer.FileName**.

  - EndIf

- Else

  - // If the implementer did not delete a link, all that needs to be done is to notify that a new link was created.

  - *Action* = FILE_ACTION_ADDED

  - *FilterMatch* = FILE_NOTIFY_CHANGE_FILE_NAME

  - Send directory change notification as per section 3.1.4.1, with **Volume** equal to **File.Volume**, **Action** equal to *Action*, **FilterMatch** equal to *FilterMatch*, and **FileName** equal to **InputBuffer.FileName**.

- EndIf

- The operation returns STATUS_SUCCESS.

### 3.1.5.14.7   FileModeInformation

**InputBuffer** is of type FILE_MODE_INFORMATION, as described in [MS-FSCC] section 2.4.24.

Pseudocode for the operation is as follows:

- The operation MUST be failed with STATUS_INVALID_PARAMETER under any of the following conditions:

  - **InputBuffer.Mode** contains any flag, as defined in [MS-FSCC] section 2.4.24, other than the following:

    - FILE_WRITE_THROUGH

    - FILE_SEQUENTIAL_ONLY

    - FILE_SYNCHRONOUS_IO_ALERT

    - FILE_SYNCHRONOUS_IO_NONALERT

- **InputBuffer.Mode** contains either FILE_SYNCHRONOUS_IO_ALERT or FILE_SYNCHRONOUS_IO_NONALERT, but **Open.Mode** contains neither FILE_SYNCHRONOUS_IO_ALERT nor FILE_SYNCHRONOUS_IO_NONALERT.

  - **Open.Mode** contains either FILE_SYNCHRONOUS_IO_ALERT or FILE_SYNCHRONOUS_IO_NONALERT, but **InputBuffer.Mode** contains neither the FILE_SYNCHRONOUS_IO_ALERT nor FILE_SYNCHRONOUS_IO_NONALERT flags.

  - **InputBuffer.Mode** contains both FILE_SYNCHRONOUS_IO_ALERT and FILE_SYNCHRONOUS_IO_NONALERT.

- If **Open.Mode** does not contain FILE_NO_INTERMEDIATE_BUFFERING:

  - If **InputBuffer.Mode** contains FILE_WRITE_THROUGH, set **Open.Mode.FILE_WRITE_THROUGH** to TRUE; otherwise set it to FALSE.

- EndIf

- If **InputBuffer.Mode** contains FILE_SEQUENTIAL_ONLY, set **Open.Mode.FILE_SEQUENTIAL_ONLY** to TRUE; otherwise set it to FALSE.

- If **Open.Mode** contains either FILE_SYNCHRONOUS_IO_ALERT or FILE_SYNCHRONOUS_IO_NONALERT:

  - If **InputBuffer.Mode** contains FILE_SYNCHRONOUS_IO_ALERT, set **Open.Mode.FILE_SYNCHRONOUS_IO_ALERT** to TRUE; otherwise set it to FALSE.

  - If **InputBuffer.Mode** contains FILE_SYNCHRONOUS_IO_NONALERT, set **Open.Mode.FILE_SYNCHRONOUS_IO_NONALERT** to TRUE; otherwise set it to FALSE.

- EndIf

- The operation returns STATUS_SUCCESS.

### 3.1.5.14.8   FileObjectIdInformation

This operation is not supported and MUST be failed with STATUS_NOT_SUPPORTED.

### 3.1.5.14.9   FilePositionInformation

**InputBuffer** is of type FILE_POSITION_INFORMATION, as described in [MS-FSCC] section 2.4.32.

Pseudocode for the operation is as follows:

- If **InputBufferSize** is less than the size, in bytes, of the FILE_POSITION_INFORMATION structure, the operation MUST be failed with STATUS_INFO_LENGTH_MISMATCH.

- The operation MUST be failed with STATUS_INVALID_PARAMETER under either of the following conditions:

  - **InputBuffer.CurrentByteOffset** is less than 0.

  - **Open.Mode** contains FILE_NO_INTERMEDIATE_BUFFERING and **InputBuffer.CurrentByteOffset** is not an integer multiple of **Open.File.Volume.SectorSize**.

- The object store MUST set Open.**CurrentByteOffset** equal to InputBuffer.CurrentByteOffset.

- The operation returns STATUS_SUCCESS.<63>

### 3.1.5.14.10   FileQuotaInformation

This operation is not supported and MUST be failed with STATUS_NOT_SUPPORTED

### 3.1.5.14.11   FileRenameInformation

**InputBuffer** is of type FILE_RENAME_INFORMATION, as described in [MS-FSCC] section 2.4.34.**Open.FileName** is the pre-existing file name that will be changed by this operation.

This routine uses the following local variables:

- Unicode strings: *PathName*, *NewLinkName*, *PrevFullLinkName*, *SourceFullLinkName*

- **Files**: *SourceDirectory*, *DestinationDirectory*

- **Links**: *TargetLink*, *NewLink*

- Boolean values (initialized to FALSE): *TargetExistsSameFile*, *ExactCaseMatch*, *MoveToNewDir*, *OverwriteSourceLink*, *RemoveTargetLink*, *FoundLink*, *MatchedShortName*

- Boolean values (initialized to TRUE): *ActivelyRemoveSourceLink*, *RemoveSourceLink*, *AddTargetLink*

- 32-bit unsigned integers: *FilterMatch*, *Action*

Pseudocode for the operation is as follows:

- The operation MUST be failed with STATUS_INVALID_PARAMETER under any of the following conditions:

  - If **InputBuffer.FileNameLength** is equal to zero.

  - If **InputBuffer.FileNameLength** is an odd number.

  - If **InputBuffer.FileNameLength** is greater than **InputBufferLength** minus the byte offset into the FILE_RENAME_INFORMATION **InputBuffer** of the **InputBuffer.FileName** field (that is, the total length of **InputBuffer** as given in **InputBufferLength** is insufficient to contain the fixed-size fields of **InputBuffer** plus the length of **InputBuffer.FileName**).

- If **Open.GrantedAccess** does not contain DELETE, as defined in [MS-SMB2] section 2.2.13.1, the operation MUST be failed with STATUS_ACCESS_DENIED.

- Split **InputBuffer.FileName** into *PathName* and *NewLinkName* per section 3.1.5.1.

- If the first character of **InputBuffer.FileName** is '\':

  - Open *DestinationDirectory* per section 3.1.5.1, setting the open file operation's parameters as follows:

    - **PathName** equal to *PathName*.

    - **DesiredAccess** equal to FILE_ADD_FILE|SYNCHRONIZE, additionally specifying FILE_ADD_SUBDIRECTORY if **Open.File.FileType** is DirectoryFile.

    - **ShareAccess** equal to FILE_SHARE_READ|FILE_SHARE_WRITE.

- **CreateOptions** equal to FILE_OPEN_FOR_BACKUP_INTENT.

- **CreateDisposition** equal to FILE_OPEN.

- If open of *DestinationDirectory* fails:

  - The operation MUST fail with the error returned by the open of *DestinationDirectory*.

- Else if *DestinationDirectory*.**Volume** is not equal to **Open.File.Volume**:

  - The operation MUST be failed with STATUS_NOT_SAME_DEVICE.

- EndIf

- Else

  - Set *DestinationDirectory* equal to **Open.Link.ParentFile**.

- EndIf

- If **Open.Stream.Oplock** is not empty, the object store MUST check for an oplock break according to the algorithm in section 3.1.4.12, with input values as follows:

  - **Open** equal to this operation's **Open**.

  - **Operation** equal to "SET_INFORMATION".

  - **OpParams** containing a member **FileInformationClass** containing FileRenameInformation.

- If the first character of **InputBuffer.FileName** is ':':

  - Perform a stream rename according to the algorithm in section 3.1.5.14.11.1, setting the stream rename algorithm's parameters as follows:

    - Pass in the current **Open**.

    - **ReplaceIfExists** equal to **InputBuffer.ReplaceIfExists**.

    - **NewStreamName** equal to **InputBuffer.FileName**.

  - If the stream rename algorithm fails, the operation MUST fail with the same status code.

  - The operation returns STATUS_SUCCESS at this point.

- EndIf

- If **Open.Link.IsDeleted** is TRUE, the operation MUST be failed with STATUS_ACCESS_DENIED.

- If **Open.File.FileType** is DirectoryFile, determine whether **Open.File** contains open files per section 3.1.4.2, with input values as follows:

  - **File** equal to **Open.File**.

  - **Open** equal to this operation's **Open**.

  - **Operation** equal to "SET_INFORMATION".

  - **OpParams** containing a member **FileInformationClass** containing FileRenameInformation.

- If **Open.File** contains open files, the operation MUST be failed with STATUS_ACCESS_DENIED.

- If **InputBuffer.FileName** is not valid as specified in [MS-FSCC] section 2.1.5, the operation MUST be failed with STATUS_OBJECT_NAME_INVALID.

- If *DestinationDirectory* is the same as **Open.Link.ParentFile**:

  - If *NewLinkName* is a case-sensitive exact match with **Open.Link.Name**, the operation MUST return STATUS_SUCCESS at this point.

- Else

  - Set *MoveToNewDir* to TRUE.

- EndIf

- If *NewLinkName* matches the **Name** or **ShortName** of any **Link** in *DestinationDirectory*.**DirectoryList** using case-sensitivity according to **Open.IsCaseInsensitive**:

  - Set *FoundLink* to TRUE.

  - Set *TargetLink* to the existing **Link** found in *DestinationDirectory*.**DirectoryList**. Because the name may have been found using a case-insensitive search (if **Open.IsCaseInsensitive** is TRUE), this preserves the case of the found name.

  - If *NewLinkName* matched *TargetLink*.**ShortName**, set *MatchedShortName* to TRUE.

  - Set *RemoveTargetLink* to TRUE.

  - If *TargetLink*.**File.FileID** equals **Open.File.FileID**, set *TargetExistsSameFile* to TRUE. This detects a rename to another existing link to the same file.

  - If (*TargetLink*.**Name** is a case-sensitive exact match with *NewLinkName*) or

    (*MatchedShortName* is TRUE and

      *TargetLink*.**ShortName** is a case-sensitive exact match with *NewLinkName*):

    - Set *ExactCaseMatch* to TRUE.

  - EndIf

  - If *TargetExistsSameFile* is TRUE:

    - If *MoveToNewDir* is FALSE:

      - If **Open.Link.ShortName** is not empty and *TargetLink*.**ShortName** is not empty (this is the case where both the source link and the (existing) requested target are part of the primary link to the same file; this case occurs, for example, in a rename that only changes the case of the name):

        - Set *ActivelyRemoveSourceLink* to FALSE.

        - Set *OverwriteSourceLink* to TRUE.

        - If *ExactCaseMatch* is TRUE, set *RemoveSourceLink* to FALSE (because this algorithm earlier succeeded upon detecting an exact match between the name by which the file was opened and the new requested name, this case only occurs when the file was

opened by one half of its primary link, and the requested rename target is the other half; for example, opening a file by its short name and renaming it to its long name).

- Else If (**Open.Link.Name** is a case-sensitive exact match with *TargetLink*.**Name**) or

  (*MatchedShortName* is TRUE and

    **Open.Link.Name** is a case-sensitive exact match with *TargetLink*.**ShortName**)
    (this detects the case where the implementer is just changing the case of a single link; for example, given a file with links "primary", "link1", "link2", all in the same directory, the implementer is doing "ren link1 LINK1", and not "ren link1 link2"):

  - Set *ActivelyRemoveSourceLink* to FALSE.

  - Set *OverwriteSourceLink* to TRUE.

  - EndIf

- EndIf

- If *ExactCaseMatch* is TRUE and

  (*OverwriteSourceLink* is FALSE or

    **Open.IsCaseInsensitive** is TRUE or

    **Open.Link.ShortName** is empty)

  - Set *RemoveTargetLink* and *AddTargetLink* to FALSE.

- EndIf

- EndIf

- If *RemoveTargetLink* is TRUE:

  - If *TargetExistsSameFile* is FALSE and **InputBuffer.ReplaceIfExists** is FALSE, the operation MUST be failed with STATUS_OBJECT_NAME_COLLISION.

  - Set *PrevFullLinkName* to the full pathname from **Open.File.Volume.RootDirectory** to *TargetLink*.

  - If *TargetExistsSameFile* is FALSE:

    - The operation MUST be failed with STATUS_ACCESS_DENIED under any of the following conditions:

      - If *TargetLink*.**File.FileType** is DirectoryFile.

      - If *TargetLink*.**File.FileAttributes.**FILE_ATTRIBUTE_READONLY is TRUE.

    - If *TargetLink*.**IsDeleted** is TRUE, the operation MUST be failed with STATUS_DELETE_PENDING.

    - If the caller does not have DELETE access to *TargetLink*.**File**:

      - If the caller does not have FILE_DELETE_CHILD access to *DestinationDirectory*:

        - The operation MUST be failed with STATUS_ACCESS_DENIED.

- EndIf

- EndIf

- For each **Stream** on *TargetLink*.**File**:

  - If *TargetLink*.**File.OpenList** contains an **Open** with a **Stream** matching the current **Stream**, and that **Stream**'s **Oplock** is not empty, the object store MUST check for an oplock break according to the algorithm in section 3.1.4.12, with input values as follows:

    - **Open** equal to this operation's **Open**.

    - **Operation** equal to SET_INFORMATION.

    - **OpParams** containing a member **FileInformationClass** containing **FileEndOfFileInformation**.

  - If there was not an oplock to be broken and *TargetLink*.**File.OpenList** contains an **Open** with a **Stream** matching the current **Stream**, the operation MUST be failed with STATUS_ACCESS_DENIED.

- EndFor

- If *TargetLink*.**File.LinkList** contains exactly one element:

  - The object store MUST delete *TargetLink*.**File** per section 3.1.5.4; if this fails, the operation MUST be failed with the same status.

- Else

  - The object store MUST delete *TargetLink* per section 3.1.5.4; if this fails, the operation MUST be failed with the same status.

  - The object store MUST post a USN change as per section 3.1.4.11 with **File** equal to **File**, **Reason** equal to (USN_REASON_HARD_LINK_CHANGE | USN_REASON_CLOSE), and **FileName** equal to *TargetLink*.**Name**.

- EndIf

- Else

  - The object store MUST post a USN change as per section 3.1.4.11 with **File** equal to **File**, **Reason** equal to USN_REASON_RENAME_OLD_NAME, and **FileName** equal to *TargetLink*.**Name**.

  - The object store MUST delete *TargetLink* per section 3.1.5.4; if this fails, the operation MUST be failed with the same status.

- EndIf

- EndIf

- EndIf

- The object store MUST post a USN change as per section 3.1.4.11 with **File** equal to **File**, **Reason** equal to USN_REASON_RENAME_OLD_NAME, and **FileName** equal to **Open.Link.Name**.

- If *RemoveSourceLink* is TRUE:

  - Set *SourceDirectory* to **Open.Link.ParentFile**.

  - If *ActivelyRemoveSourceLink* is TRUE:

    - Remove **Open.Link** from **Open.File.LinkList**.

    - Remove **Open.Link** from **Open.Link.ParentFile.DirectoryList**.

    - A new **TunnelCacheEntry** object *TunnelCacheEntry* MUST be constructed and added to the **Open.File.Volume.TunnelCacheList** as follows:

      - *TunnelCacheEntry*.**EntryTime** MUST be set to the current time.

      - *TunnelCacheEntry*.**ParentFile** MUST be set to **Open.Link.ParentFile**.

      - *TunnelCacheEntry*.**FileName** MUST be set to **Open.Link.Name**.

      - *TunnelCacheEntry*.**FileShortName** MUST be set to **Open.Link.ShortName**.

      - If **Open.FileName** matches **Open.Link.ShortName**, then *TunnelCacheEntry*.**KeyByShortName** MUST be set to TRUE, else *TunnelCacheEntry*.**KeyByShortName** MUST be set to FALSE.

      - *TunnelCacheEntry*.**FileCreationTime** MUST be set to **Open.File.CreationTime**.

      - *TunnelCacheEntry*.**FileObjectId** MUST be set to **Open.File.ObjectId**.

    - EndIf

    - If **Open.File.FileType** is DirectoryFile, then **Open.File** MUST have every **TunnelCacheEntry** associated with it invalidated:

      - For every *ExistingTunnelCacheEntry* in **Open.File.Volume.TunnelCacheList**:

        - If *ExistingTunnelCacheEntry*.**ParentFile** matches **Open.File**, then *ExistingTunnelCacheEntry* MUST be removed from **Open.File.Volume.TunnelCacheList**.

      - EndFor

    - EndIf

  - EndIf

  - Set *SourceFullLinkName* to **Open.FileName**.

- EndIf

- If *AddTargetLink* is TRUE:

  - The operation MUST be failed with STATUS_ACCESS_DENIED if either of the following conditions are true:

    - **Open.File.FileType** is DirectoryFile and the caller does not have FILE_ADD_SUBDIRECTORY access on *DestinationDirectory*.

- **Open.File.FileType** is DataFile and the caller does not have FILE_ADD_FILE access on *DestinationDirectory*.

- The object store MUST create a new **Link** object *NewLink*, initialized as follows:

  - *NewLink*.**File** equal to **Open.File**.

  - *NewLink*.**ParentFile** equal to *DestinationDirectory*.

  - All other fields set to zero.

- If **Open.File.FileType** is DataFile and **Open.IsCaseInsensitive** is TRUE, and tunnel caching is implemented, the object store MUST search **Open.File.Volume.TunnelCacheList** for a *TunnelCacheEntry* where *TunnelCacheEntry*.**ParentFile** equals *DestinationDirectory* and either (*TunnelCacheEntry*.**KeyByShortName** is FALSE and *TunnelCacheEntry*.**FileName** matches *NewLinkName*) or (*TunnelCacheEntry*.**KeyByShortName** is TRUE and *TunnelCacheEntry*.**FileShortName** matches *NewLinkName*). If such an entry is found:

  - Set *NewLink*.**File.CreationTime** to *TunnelCacheEntry*.**FileCreationTime**.

  - Set *NewLink*.**File.PendingNotifications.** FILE_NOTIFY_CHANGE_CREATION to TRUE.

  - Set *NewLink*.**File.ObjectId** to *TunnelCacheEntry*.**FileObjectId**.

  - Set *NewLink*.**Name** to *TunnelCacheEntry*.**FileName**.

  - Set *NewLink*.**ShortName** to *TunnelCacheEntry*.**FileShortName** if that name is not already in use among all names and short names in *NewLink*.**ParentFile.DirectoryList**.

  - Remove *TunnelCacheEntry* from *NewLink*.**File.Volume.TunnelCacheList**.

- Else:

  - Set *NewLink*.**Name** to *NewLinkName*.

- EndIf

- If **Open.Link.ShortName** is not empty and **Open.IsCaseInsensitive** is TRUE and *NewLink*.**ShortName** is empty, then if short names are enabled, the object store MUST create a short name as follows:

  - If *NewLink*.**Name** is 8.3-compliant as described in [MS-FSCC] section 2.1.5.2.1:

    - Set *NewLink*.**ShortName** to *NewLink*.**Name**.

  - Else:

    - Generate a *NewLink*.**ShortName** that is 8.3-compliant as described in [MS-FSCC] section 2.1.5.2.1. The string chosen is implementation-specific, but MUST be unique among all names and short names present in *DestinationDirectory*.**DirectoryList**.

  - EndIf

- EndIf

- The object store MUST add *NewLink* to *DestinationDirectory*.**DirectoryList**.

- The object store MUST replace **Open.Link** with *NewLink*.

- If *MoveToNewDir* is TRUE:

    - *DestinationDirectory*.**LastModifiedTime** MUST be updated.

    - *DestinationDirectory*.**LastAccessedTime** MUST be updated.

    - *DestinationDirectory*.**LastChangeTime** MUST be updated.

    - EndIf

- EndIf

- The object store MUST change the compname component (as specified in [MS-FSCC] section 2.1.5) of **Open.FileName** to *NewLinkName*.

- If *RemoveSourceLink* is TRUE:

    - *SourceDirectory*.**LastModifiedTime** MUST be updated.

    - *SourceDirectory*.**LastAccessedTime** MUST be updated.

    - *SourceDirectory*.**LastChangeTime** MUST be updated.

- EndIf

- The object store MUST update **Open.File.LastChangeTime**.<64>

- If **Open.File.FileType** is DataFile, the object store MUST set **Open.File.FileAttributes.** FILE_ATTRIBUTE_ARCHIVE.

- *FilterMatch* = 0

- If *RemoveTargetLink* is TRUE and *OverwriteSourceLink* is FALSE and *ExactCaseMatch* is FALSE:

    - If *TargetLink*.**File.FileType** is DirectoryFile

        - *FilterMatch* = FILE_NOTIFY_CHANGE_DIR_NAME

    - Else

        - *FilterMatch* = FILE_NOTIFY_CHANGE_FILE_NAME

    - EndIf

    - The object store MUST report a directory change notification per section 3.1.4.1 with **Volume** equal to **Open**.**File.Volume**, **Action** equal to FILE_ACTION_REMOVED, and **FileName** set to *PrevFullLinkName* with a **FilterMatch** of *FilterMatch*.

- EndIf

- If *RemoveSourceLink* is TRUE:

    - If **Open.File**.**FileType** is DirectoryFile

        - *FilterMatch* = FILE_NOTIFY_CHANGE_DIR_NAME

    - Else

        - *FilterMatch* = FILE_NOTIFY_CHANGE_FILE_NAME

- EndIf

- If *MoveToNewDir* is TRUE or *AddTargetLink* is FALSE or *RemoveTargetLink* and *ExactCaseMatch* are TRUE: *Action* = FILE_ACTION_REMOVED

- Else

  - *Action* = FILE_ACTION_REMOVED_OLD_NAME

- EndIf

- The object store MUST report a directory change notification per section [3.1.4.1](#) with **Volume** equal to **Open.File.Volume**, **Action** equal to *Action*, and **FileName** set to *SourceFullLinkName* with a **FilterMatch** of *FilterMatch*.

- EndIf

- If *FoundLink* is FALSE or (*OverwriteSourceLink* is TRUE and *ExactCaseMatch* is FALSE) or (*RemoveTargetLink* is TRUE and *ExactCaseMatch* is FALSE):

  - If *MoveToNewDir* is TRUE, set *Action* to FILE_ACTION_ADDED; otherwise set *Action* to FILE_ACTION_RENAMED_NEW_NAME.

- Else If *RemoveTargetLink* is TRUE and *TargetExistsSameFile* is FALSE:

  - *FilterMatch* = FILE_NOTIFY_CHANGE_ATTRIBUTES | FILE_NOTIFY_CHANGE_SIZE | FILE_NOTIFY_CHANGE_LAST_WRITE | FILE_NOTIFY_CHANGE_LAST_ACCESS | FILE_NOTIFY_CHANGE_CREATION | FILE_NOTIFY_CHANGE_SECURITY | FILE_NOTIFY_CHANGE_EA

  - *Action* = FILE_ACTION_MODIFIED

- EndIf

- If *FilterMatch* != 0:

  - The object store MUST report a directory change notification per section [3.1.4.1](#) with **Volume** equal to **Open.File.Volume**, **Action** equal to *Action*, and **FileName** set to **Open.FileName** with a **FilterMatch** of *FilterMatch*.

- EndIf

- The operation returns STATUS_SUCCESS.

### 3.1.5.14.11.1   Algorithm for Performing Stream Rename

The inputs for a stream rename are:

- **Open:** an **Open** for the stream being renamed.

- **ReplaceIfExists:** A Boolean value. If TRUE and the target stream exists and the operation is successful, the target stream MUST be replaced. If FALSE and the target stream exists, the operation MUST fail.

- **NewStreamName:** A Unicode string indicating the new name for the stream. This string MUST begin with the Unicode character ":".

The stream rename algorithm uses the following local variables:

- Unicode strings: *StreamName*, *StreamTypeName*

- **Streams:** *TargetStream*, *NewDefaultStream*

Pseudocode for the algorithm is as follows:

- Split **NewStreamName** into a stream name component *StreamName* and attribute type component *StreamTypeName*, using the character ":" as a delimiter.

- The operation MUST be failed with STATUS_INVALID_PARAMETER under any of the following conditions:

  - The last character of **NewStreamName** is ":".

  - The character ":" occurs more than three times in **NewStreamName**.

  - If *StreamName* contains any characters invalid for a streamname as specified in [MS-FSCC] section 2.1.5, or any wildcard characters as defined in section 3.1.4.3.

  - If *StreamTypeName* contains any characters invalid for a streamname as specified in [MS-FSCC] section 2.1.5, or any wildcard characters as defined in section 3.1.4.3.

  - Both *StreamName* and *StreamTypeName* are zero-length.

  - *StreamName* is more than 255 Unicode characters in length.

  - If *StreamName* is zero-length and **Open.File.FileType** is DirectoryFile, because a DirectoryFile cannot have an unnamed data stream.

- The operation MUST be failed with STATUS_OBJECT_TYPE_MISMATCH if either of the following conditions are true:

  - **Open.Stream.StreamType** is DataStream and *StreamTypeName* is not the Unicode string "$DATA".

  - **Open.Stream.StreamType** is DirectoryStream and *StreamTypeName* is not the Unicode string "$INDEX_ALLOCATION".

- If **Open.Stream.StreamType** is DirectoryStream, the operation MUST be failed with STATUS_INVALID_PARAMETER.

- If *StreamName* is a case-insensitive match with **Open.Stream.Name**, the operation MUST return STATUS_SUCCESS at this point.

- If the length of *StreamName* is not 0, the object store MUST search **Open.File.StreamList** for a **Stream** with **Stream.Name** matching *StreamName*, ignoring case, setting *TargetStream* to the result.

- If *TargetStream* is found:

  - If **ReplaceIfExists** is FALSE, the operation MUST be failed with STATUS_OBJECT_NAME_COLLISION.

  - If *TargetStream*.**File.OpenList** contains any Opens to *TargetStream*, the operation MUST be failed with STATUS_INVALID_PARAMETER.

  - If *TargetStream*.**Size** is not 0, the operation MUST be failed with STATUS_INVALID_PARAMETER.

- If *TargetStream*.**AllocationSize** is not 0, the object store SHOULD release any associated allocation and MUST set *TargetStream*.**AllocationSize** to 0.

- Else // *TargetStream* is not found:

  - The object store MUST build a new **Stream** object *TargetStream* with all fields initially set to zero.

  - Set *TargetStream*.**File** to **Open.File**.

  - Add *TargetStream* to **Open.File.StreamList**.

- EndIf

- Set *TargetStream*.**Name** to *StreamName*.

- Set *TargetStream*.**Size** to **Open.Stream.Size**.

- If **Open.Stream.IsSparse** is TRUE, set *TargetStream*.**IsSparse** to TRUE.

- Move **Open.Stream.ExtentList** to *TargetStream*.

- Set *TargetStream*.**AllocationSize** to **Open.Stream.AllocationSize**.

- If **Open.Stream.Name** is empty, the object store MUST create a new default unnamed stream for the file as follows:

  - The object store MUST build a new **Stream** object *NewDefaultStream* with all fields initially set to zero.

  - Set *NewDefaultStream*.**File** to **Open.File**.

  - Add *NewDefaultStream* to **Open.File.StreamList**.

- EndIf

- Remove **Open.Stream** from **Open.File.StreamList**.

- Set **Open.Stream** to *TargetStream*.

- Return STATUS_SUCCESS.

### 3.1.5.14.12   FileSfioReserveInformation

This operation is not supported and MUST be failed with STATUS_NOT_SUPPORTED.

### 3.1.5.14.13   FileShortNameInformation

**InputBuffer** is of type FILE_NAME_INFORMATION, as described in [MS-FSCC] section 2.4.37.

Pseudocode for the algorithm is as follows:

- If **Open.File.Volume.IsReadOnly** is TRUE, the operation MUST be failed with STATUS_MEDIA_WRITE_PROTECTED.

- The operation MUST be failed with STATUS_INVALID_PARAMETER under any of the following conditions:

- If **InputBuffer.FileName** starts with '\'.

- If **Open.File** is equal to **Open.File.Volume.RootDirectory**.

- If **Open.Stream.StreamType** is DataStream and **Open.Stream.Name** is not empty.

- If **InputBuffer.FileName** is not a valid 8.3 name as described in [MS-FSCC] section 2.1.5.2.1.

- If **Open.IsCaseInsensitive** is FALSE.

- The operation MUST be failed with STATUS_ACCESS_DENIED under any of the following conditions:

  - If **Open.GrantedAccess** contains neither FILE_WRITE_DATA nor FILE_WRITE_ATTRIBUTES as defined in [MS-SMB2] section 2.2.13.1.

  - If **Open.Link.IsDeleted** is TRUE.

  - If **Open.Mode.FILE_DELETE_ON_CLOSE** is TRUE.

- If **Open.HasRestoreAccess** is FALSE, the operation MUST be failed with STATUS_PRIVILEGE_NOT_HELD.

- If **Open.File.Volume.GenerateShortNames** is FALSE, the operation MUST be failed with STATUS_SHORT_NAMES_NOT_ENABLED_ON_VOLUME.

- Determine whether **Open.File** contains open files as per section 3.1.4.2, with input values as follows:

  - **File** equal to **Open.File**.

  - **Open** equal to this operation's **Open**.

  - **Operation** equal to "SET_INFORMATION".

  - **OpParams** containing a member **FileInformationClass** containing **FileShortNameInformation**.

- If **Open.File** contains open files, the operation MUST be failed with STATUS_ACCESS_DENIED.

- If **Open.File.FileType** is DirectoryFile:

  - *FilterMatch* = FILE_NOTIFY_CHANGE_DIR_NAME

- Else

  - *FilterMatch* =FILE_NOTIFY_CHANGE_FILE_NAME

- EndIf

- If **InputBuffer.FileName** is empty:

  - If **Open.Link.ShortName** is not empty:

    - *OldShortName* **= Open.Link.ShortName**.

    - Set **Open.Link.ShortName** to empty.

- Send directory change notification as per section 3.1.4.1, with **Volume** equal to **Open.File.Volume**, **Action** equal to FILE_ACTION_REMOVED, and **FileName** set to *OldShortName* with a **FilterMatch** of *FilterMatch*.

- EndIf

- Return STATUS_SUCCESS.

- EndIf

- If **InputBuffer.FileName** equals **Open.Link.ShortName**, return STATUS_SUCCESS.

- For each *Link* in **Open.Link.ParentFile.DirectoryList**:

  - If *Link* is not equal to **Open.Link** and **InputBuffer.FileName** matches *Link*.**Name** or *Link*.**ShortName**, the operation MUST be failed with STATUS_OBJECT_NAME_COLLISION.

- EndFor

- If **Open.Link.ShortName** is not empty:

  - *OldShortName* = **Open.Link.ShortName**.

  - Set **Open.Link.ShortName** to **InputBuffer.FileName**.

  - Send directory change notification as per section 3.1.4.1, with **Volume** equal to **Open**.**File.Volume**, **Action** equal to FILE_ACTION_RENAMED_OLD_NAME, and **FileName** set to *OldShortName* with a **FilterMatch** of *FilterMatch*.

  - Send directory change notification as per section 3.1.4.1, with **Volume** equal to **Open**.**File.Volume**, **Action** equal to FILE_ACTION_RENAMED_NEW_NAME, and **FileName** set to **InputBuffer.FileName** with a **FilterMatch** of *FilterMatch*.

  - Return STATUS_SUCCESS.

- EndIf

- For each *Link* in **Open.File.LinkList**:

  - If *Link*.**ShortName** is not empty, the operation MUST be failed with STATUS_OBJECT_NAME_COLLISION.

- EndFor

- Set **Open.Link.ShortName** to **InputBuffer.FileName**.

- Send directory change notification as per section 3.1.4.1, with **Volume** equal to **Open**.**File.Volume**, **Action** equal to FILE_ACTION_RENAMED_NEW_NAME, and **FileName** set to **InputBuffer.FileName** with a **FilterMatch** of *FilterMatch*.

- Return STATUS_SUCCESS.

### 3.1.5.14.14   FileValidDataLengthInformation

**InputBuffer** is of type FILE_VALID_DATA_LENGTH_INFORMATION as described in [MS-FSCC] section 2.4.41.<65>

Pseudocode for the operation is as follows:

- If **Open.File.Volume.IsReadOnly** is TRUE, the operation MUST be failed with STATUS_MEDIA_WRITE_PROTECTED.

- If **Open.HasManageVolumeAccess** is FALSE, the operation MUST be failed with STATUS_PRIVILEGE_NOT_HELD.

- The operation MUST be failed with STATUS_INVALID_PARAMETER under any of the following conditions:

    - If **Open.Stream.ValidDataLength** is greater than **InputBuffer.ValidDataLength**.

    - If **Open.Stream.IsCompressed** is TRUE.

    - If **Open.Stream.IsSparse** is TRUE.

- If **Open.Stream.Oplock** is not empty, the object store MUST check for an oplock break according to the algorithm in section 3.1.4.12, with input values as follows:

    - **Open** equal to this operation's **Open**.

    - **Operation** equal to "SET_INFORMATION".

    - **OpParams** containing a member **FileInformationClass** containing **FileValidDataLengthInformation**.

- **Open.Stream.ValidDataLength** MUST be set to **InputBuffer.ValidDataLength**.

- Return STATUS_SUCCESS.

### 3.1.5.15  Server Requests Setting of File System Information

The server provides:

- **Open:** The **Open** on which volume information is being applied.

- **FsInformationClass:** The type of information being applied, as specified in [MS-FSCC] section 2.5.

- **InputBuffer:** A buffer that contains the volume information to be applied to the object.

- **InputBufferSize:** The size of the buffer provided.

The object store MUST return:

- **Status:** An NTSTATUS code indicating the result of the operation.

#### 3.1.5.15.1  FileFsVolumeInformation

This operation is not supported and MUST be failed with STATUS_ INVALID_INFO_CLASS.

#### 3.1.5.15.2  FileFsLabelInformation

This operation is not supported and MUST be failed with STATUS_ INVALID_INFO_CLASS.

#### 3.1.5.15.3  FileFsSizeInformation

This operation is not supported and MUST be failed with STATUS_ INVALID_INFO_CLASS.

### 3.1.5.15.4   FileFsDeviceInformation

This operation is not supported and MUST be failed with STATUS_NOT_SUPPORTED.

### 3.1.5.15.5   FileFsAttributeInformation

This operation is not supported and MUST be failed with STATUS_ INVALID_INFO_CLASS.

### 3.1.5.15.6   FileFsControlInformation

**InputBuffer** is of type FILE_FS_CONTROL_INFORMATION, as described in [MS-FSCC] section 2.5.2.

Pseudocode for the operation is as follows:

- If **InputBufferSize** is smaller than **BlockAlign(sizeof(**FILE_FS_CONTROL_INFORMATION**)**, 8**)** the operation MUST be failed with STATUS_INVALID_INFO_CLASS.

- Support for this operation is optional. If the object store does not implement this functionality, the operation MUST be failed with STATUS_INVALID_PARAMETER.

- If **Open.File.Volume.IsQuotasSupported** is FALSE, the operation MUST be failed with STATUS_VOLUME_NOT_UPGRADED.

- **Open.File.Volume** MUST be updated as follows:

  - **Open.File.Volume.DefaultQuotaThreshold** set to **InputBuffer.DefaultQuotaThreshold**.

  - **Open**.**File**.**Volume**.**DefaultQuotaLimit** set to **InputBuffer.DefaultQuotaLimit**.

  - **Open**.**File**.**Volume**.**VolumeQuotaState** set to **InputBuffer.FileSystemControlFlags**. The FILE_VC_QUOTAS_INCOMPLETE and FILE_VC_QUOTAS_REBUILDING flags as well as any undefined flags are cleared from **InputBuffer.FileSystemControlFlags** before being saved.

- Upon successful completion of the operation, the object store MUST return:

  - **Status** set to STATUS_SUCCESS.

### 3.1.5.15.7   FileFsFullSizeInformation

This operation is not supported and MUST be failed with STATUS_ INVALID_INFO_CLASS.

### 3.1.5.15.8   FileFsObjectIdInformation

**InputBuffer** is a FILE_FS_OBJECTID_INFORMATION structure, as described in [MS-FSCC] section 2.5.6.

Pseudocode for the operation is as follows:

- If **InputBufferSize** is less than **sizeof**(FILE_FS_OBJECTID_INFORMATION), the operation MUST be failed with STATUS_INVALID_INFO_CLASS.

- Support for ObjectIDs is optional. If the object store does not implement this functionality, the operation MUST be failed with STATUS_INVALID_PARAMETER.

- If **Open.File.Volume.IsObjectIDsSupported** is FALSE, the operation MUST be failed with STATUS_VOLUME_NOT_UPGRADED.

- **Open.File.Volume** MUST be updated as follows:

  - **Open.File.Volume.VolumeId** set to **InputBuffer.ObjectId**.

  - **Open.File.Volume.ExtendedInfo** set to **InputBuffer.ExtendedInfo**.

- Upon successful completion of the operation, the object store MUST return:

  - **Status** set to STATUS_SUCCESS.

### 3.1.5.15.9   FileFsDriverPathInformation

This operation is not supported and MUST be failed with STATUS_ INVALID_INFO_CLASS.

### 3.1.5.16   Server Requests Setting of Security Information

If the object store does not implement security, the operation MUST be failed with STATUS_INVALID_DEVICE_REQUEST.

The server provides:

- **Open** - The **Open** on which security information is being applied.

- **SecurityInformation** - A SECURITY_INFORMATION data type as defined in [MS-DTYP] section 2.4.7.

- **InputBuffer** - A buffer that contains the security descriptor to be applied to the object. The security descriptor is a SECURITY_DESCRIPTOR structure in self-relative format, as described in [MS-DTYP] section 2.4.6.

- **InputBufferSize** - The size of the buffer provided.

On completion, the object store MUST return:

- **Status** - An NTSTATUS code indicating the result of the operation.

This routine uses the following local variables:

- Boolean values (initialized to FALSE): *DisableOwnerAces*, *ServerObject*, *DaclUntrusted*

The operation MUST be failed with STATUS_ACCESS_DENIED under any of the following conditions:

- **SecurityInformation** contains any of OWNER_SECURITY_INFORMATION, GROUP_SECURITY_INFORMATION, or LABEL_SECURITY_INFORMATION, and **Open.GrantedAccess** does not contain WRITE_OWNER.

- **SecurityInformation** contains DACL_SECURITY_INFORMATION and **Open.GrantedAccess** does not contain WRITE_DAC.

- **SecurityInformation** contains SACL_SECURITY_INFORMATION and **Open.GrantedAccess** does not contain ACCESS_SYSTEM_SECURITY.

Pseudocode for the operation is as follows:

- If **Open.Stream.StreamType** is DataStream and **Open.Stream.Name** is not zero-length, the operation MUST be failed with STATUS_INVALID_PARAMETER; security information may only be set on a file or directory handle, not on a stream handle.

- The object store MUST post a USN change as per section [3.1.4.11](#) with **File** equal to **File**, **Reason** equal to USN_REASON_SECURITY_CHANGE, and **FileName** equal to **Open.Link.Name**.

- If the Server Security (SS) bit is set in **InputBuffer.Control**, set *ServerObject* to TRUE, otherwise set it to FALSE.

- If the DACL Trusted (DT) bit is set in **InputBuffer.Control**, set *DaclUntrusted* to FALSE, otherwise set it to TRUE.

- If **SecurityInformation** contains OWNER_SECURITY_INFORMATION:

  - If **SecurityInformation** contains DACL_SECURITY_INFORMATION, set *DisableOwnerAces* to FALSE, otherwise set it to TRUE.

  - If **InputBuffer.OwnerSid** is not present, the operation MUST be failed with STATUS_INVALID_OWNER.

  - If **InputBuffer.OwnerSid** is not a valid owner SID for a file in the object store, as determined in an implementation-specific manner, the object store MUST return STATUS_INVALID_OWNER.

- Else

  - If **Open.File.SecurityDescriptor.Owner** is NULL, the operation MUST be failed with STATUS_INVALID_OWNER.

- EndIf

- The object store MUST set **Open.File.SecurityDescriptor** to **InputBuffer**.

- If **Open.File.FileType** is not DirectoryFile:

  - The object store MUST set **Open.File.FileAttributes.**FILE_ATTRIBUTE_ARCHIVE.

  - The object store MUST update **Open.File.LastChangeTime**.[<66>](#)

- EndIf

- The operation returns STATUS_SUCCESS.

### 3.1.5.17   Server Requests an Oplock

The server provides:

- **Open** - The **Open** on which the oplock is being requested.

- **Type** - The type of oplock being requested. Valid values are as follows:

  - LEVEL_TWO (Corresponds to SMB2_OPLOCK_LEVEL_II as described in [[MS-SMB2]](#) section 2.2.13.**)**

  - LEVEL_ONE (Corresponds to SMB2_OPLOCK_LEVEL_EXCLUSIVE as described in [[MS-SMB2]](#) section 2.2.13.)

  - LEVEL_BATCH (Corresponds to SMB2_OPLOCK_LEVEL_BATCH as described in [[MS-SMB2]](#) section 2.2.13.)

- LEVEL_GRANULAR (Corresponds to SMB2_OPLOCK_LEVEL_LEASE as described in [MS-SMB2] section 2.2.13.) If this oplock type is specified, the server MUST additionally provide the **RequestedOploclLevel** parameter.

- **RequestedOplockLevel** - A combination of zero or more of the following flags, which are only given for LEVEL_GRANULAR **Type** Oplocks:

  - READ_CACHING

  - HANDLE_CACHING

  - WRITE_CACHING

Following is a list of legal nonzero combinations of **RequestedOplockLevel:**

- READ_CACHING

- READ_CACHING | WRITE_CACHING

- READ_CACHING | HANDLE_CACHING

- READ_CACHING | WRITE_CACHING | HANDLE_CACHING

Pseudocode for the operation is as follows:

- If the oplock is not granted, the request completes at this point.

- If the oplock is granted, the request does not complete until the oplock is broken; the operation waits for this to happen. Processing of an oplock break is described in section 3.1.5.17.3. Whether the oplock is granted or not, the object store MUST return:

  - **Status** - An NTSTATUS code indicating the result of the operation.

- If the oplock is granted, then when the oplock breaks and the request finally completes, the object store MUST additionally return:

  - **NewOplockLevel:** The type of oplock the requested oplock has been broken to. Valid values are as follows:

    - LEVEL_NONE (that is, no oplock)

    - LEVEL_TWO

    - A combination of one or more of the following flags:

      - READ_CACHING

      - HANDLE_CACHING

      - WRITE_CACHING

  - **AcknowledgeRequired:** A Boolean value; TRUE if the server MUST acknowledge the oplock break, FALSE if not, as specified in section 3.1.5.17.2.

- If **Type** is LEVEL_EXCLUSIVE or LEVEL_BATCH:

  - The operation MUST be failed with STATUS_OPLOCK_NOT_GRANTED under either of the following conditions:

- **Open.File.OpenList** contains more than one Open whose **Stream** is the same as **Open.Stream**.

- **Open.Mode** contains either FILE_SYNCHRONOUS_IO_ALERT or FILE_SYNCHRONOUS_IO_NONALERT.

- Request an exclusive oplock according to the algorithm in section 3.1.5.17.1, setting the algorithm's parameters as follows:

  - Pass in the current **Open**.

  - **RequestedOplock** equal to **Type**.

- The operation MUST at this point return any status code returned by the exclusive oplock request algorithm.

- Else If **Type** is LEVEL_TWO:

  - The operation MUST be failed with STATUS_OPLOCK_NOT_GRANTED under either of the following conditions:

    - **Open.Stream.ByteRangeLockList** is not empty.

    - **Open.Mode** contains either FILE_SYNCHRONOUS_IO_ALERT or FILE_SYNCHRONOUS_IO_NONALERT.

  - Request a shared oplock according to the algorithm in section 3.1.5.17.2, setting the algorithm's parameters as follows:

    - Pass in the current **Open**.

    - **RequestedOplock** equal to **Type**.

    - **GrantingInAck** equal to FALSE.

  - The operation MUST  at this point return any status code returned by the shared oplock request algorithm.

- Else If **Type** is LEVEL_GRANULAR:

  - If **RequestedOplockLevel** is READ_CACHING or (READ_CACHING|HANDLE_CACHING):

    - The operation MUST be failed with STATUS_OPLOCK_NOT_GRANTED under either of the following conditions:

      - **Open.Stream.ByteRangeLockList** is not empty.

      - **Open.Mode** contains either FILE_SYNCHRONOUS_IO_ALERT or FILE_SYNCHRONOUS_IO_NONALERT.

    - Request a shared oplock according to the algorithm in section 3.1.5.17.2, setting the algorithm's parameters as follows:

      - Pass in the current **Open**.

      - **RequestedOplock** equal to **RequestedOplockLevel**.

      - **GrantingInAck** equal to FALSE.

- The operation MUST at this point return any status code returned by the shared oplock request algorithm.

- Else If **RequestedOplockLevel** is (READ_CACHING|WRITE_CACHING) or (READ_CACHING|WRITE_CACHING|HANDLE_CACHING):

  - If **Open.Mode** contains either FILE_SYNCHRONOUS_IO_ALERT or FILE_SYNCHRONOUS_IO_NONALERT, the operation MUST be failed with STATUS_OPLOCK_NOT_GRANTED.

  - Request an exclusive oplock according to the algorithm in section 3.1.5.17.1, setting the algorithm's parameters as follows:

    - Pass in the current **Open**.

    - **RequestedOplock** equal to **RequestedOplockLevel**.

  - The operation MUST at this point return any status code returned by the exclusive oplock request algorithm.

- Else if **RequestedOplockLevel** is 0 (that is, no flags):

  - The operation MUST return STATUS_SUCCESS at this point.

- Else

  - The operation MUST be failed with STATUS_INVALID_PARAMETER.

- EndIf

- EndIf

### 3.1.5.17.1   Algorithm to Request an Exclusive Oplock

The inputs for requesting an exclusive oplock are:

- **Open:** The **Open** on which the oplock is being requested.

- **RequestedOplock:** The oplock type being requested.

The exclusive oplock request algorithm uses the following local variables:

- Boolean value (initialized to FALSE): *GrantExclusiveOplock*

Pseudocode for the algorithm is as follows:

- If **Open.Stream.Oplock** is empty:

  - Build a new **Oplock** object with fields initialized as follows:

    - **Oplock.State** set to NO_OPLOCK.

    - All other fields set to 0/empty.

  - Store the new **Oplock** object in **Open.Stream.Oplock**.

- EndIf

- If **Open.Stream.Oplock.State** contains LEVEL_TWO_OPLOCK or NO_OPLOCK:

- If **Open.Stream.Oplock.State** contains LEVEL_TWO_OPLOCK and **RequestedOplock** contains one or more of READ_CACHING, HANDLE_CACHING, or WRITE_CACHING, the operation MUST be failed with STATUS_OPLOCK_NOT_GRANTED.

- If **Open.Stream.Oplock.State** is equal to LEVEL_TWO_OPLOCK:

- Remove the first **Open** *ThisOpen* from **Open.Stream.Oplock.IIOplocks** (there should be exactly one present), and notify the server of an oplock break according to the algorithm in section 3.1.5.17.3, setting the algorithm's parameters as follows:

  - **BreakingOplockOpen** equal to *ThisOpen*.

  - **NewOplockLevel** equal to LEVEL_NONE.

  - **AcknowledgeRequired** equal to FALSE.

  - **ReturnStatus** equal to STATUS_SUCCESS.

- (The operation does not end at this point; this call to 3.1.5.17.3 completes some earlier call to 3.1.5.17.2.)

- EndIf

- If **Open.File.OpenList** contains more than one Open whose **Stream** is the same as **Open.Stream**, and NO_OPLOCK is present in **Open.Stream.Oplock.State**, the operation MUST be failed with STATUS_OPLOCK_NOT_GRANTED.

- If **Open.Stream.IsDeleted** is TRUE and **RequestedOplock** contains HANDLE_CACHING, the operation MUST be failed with STATUS_OPLOCK_NOT_GRANTED.

- Set *GrantExclusiveOplock* to TRUE.

- Else If (**Open.Stream.Oplock.State** contains one or more of READ_CACHING, WRITE_CACHING, or HANDLE_CACHING) and

- (**Open.Stream.Oplock.State** contains none of BREAK_TO_TWO, BREAK_TO_NONE, BREAK_TO_TWO_TO_NONE, BREAK_TO_READ_CACHING, BREAK_TO_WRITE_CACHING, BREAK_TO_HANDLE_CACHING, or BREAK_TO_NO_CACHING) and (**Open.Stream.Oplock.State.RHBreakQueue** is empty):

  - // This is a granular oplock and it is not breaking.

  - If **RequestedOplock** contains none of READ_CACHING, WRITE_CACHING, or HANDLE_CACHING, the operation MUST be failed with STATUS_OPLOCK_NOT_GRANTED.

  - If **Open.Stream.IsDeleted** is TRUE and **RequestedOplock** contains HANDLE_CACHING, the operation MUST be failed with STATUS_OPLOCK_NOT_GRANTED.

  - Switch (**Open.Stream.Oplock.State**):

    - Case READ_CACHING:

      - If **RequestedOplock** is neither (READ_CACHING|WRITE_CACHING) nor (READ_CACHING|WRITE_CACHING|HANDLE_CACHING), the operation MUST be failed with STATUS_OPLOCK_NOT_GRANTED.

      - For each **Open** *ThisOpen* in **Open.Stream.Oplock.ROplocks:**

- If *ThisOpen*.**OplockKey** != **Open.OplockKey**, the operation MUST be failed with STATUS_OPLOCK_NOT_GRANTED.

- EndFor

- For each **Open** *ThisOpen* in **Open.Stream.Oplock.ROplocks:**

  - Remove *ThisOpen* from **Open.Stream.Oplock.ROplocks**.

  - Notify the server of an oplock break according to the algorithm in section 3.1.5.17.3, setting the algorithm's parameters as follows:

    - **BreakingOplockOpen** equal to *ThisOpen*.

    - **NewOplockLevel** equal to **RequestedOplock**.

    - **AcknowledgeRequired** equal to FALSE.

    - **ReturnStatus** equal to STATUS_OPLOCK_SWITCHED_TO_NEW_HANDLE.

  - (The operation does not end at this point; this call to 3.1.5.17.3 completes some earlier call to 3.1.5.17.2.)

- EndFor

- Set *GrantExclusiveOplock* to TRUE.

- EndCase

- Case (READ_CACHING|HANDLE_CACHING):

  - If **RequestedOplock** is not (READ_CACHING|WRITE_CACHING|HANDLE_CACHING) or **Open.Stream.Oplock.RHBreakQueue** is not empty, the operation MUST be failed with STATUS_OPLOCK_NOT_GRANTED.

  - For each **Open** *ThisOpen* in **Open.Stream.Oplock.RHOplocks:**

    - If *ThisOpen*.**OplockKey** != **Open.OplockKey**, the operation MUST be failed with STATUS_OPLOCK_NOT_GRANTED.

  - EndFor

  - For each **Open** *ThisOpen* in **Open.Stream.Oplock.RHOplocks:**

    - Remove *ThisOpen* from **Open.Stream.Oplock.RHOplocks**.

    - Notify the server of an oplock break according to the algorithm in section 3.1.5.17.3, setting the algorithm's parameters as follows:

      - **BreakingOplockOpen** equal to *ThisOpen*.

      - **NewOplockLevel** equal to **RequestedOplock**.

      - **AcknowledgeRequired** equal to FALSE.

      - **ReturnStatus** equal to STATUS_OPLOCK_SWITCHED_TO_NEW_HANDLE.

    - (The operation does not end at this point; this call to 3.1.5.17.3 completes some earlier call to 3.1.5.17.2.)

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- EndFor

- Set *GrantExclusiveOplock* to TRUE.

- EndCase

- Case (READ_CACHING|WRITE_CACHING|HANDLE_CACHING|EXCLUSIVE):

  - If **RequestedOplock** is not (READ_CACHING|WRITE_CACHING|HANDLE_CACHING), the operation MUST be failed with STATUS_OPLOCK_NOT_GRANTED.

- // Deliberate FALL-THROUGH to next Case statement.

- Case (READ_CACHING|WRITE_CACHING|EXCLUSIVE):

  - If **RequstedOplock** is neither (READ_CACHING|WRITE_CACHING|HANDLE_CACHING) nor (READ_CACHING|WRITE_CACHING), the operation MUST be failed with STATUS_OPLOCK_NOT_GRANTED.

  - If **Open.OplockKey** != **Open.Stream.Oplock.ExclusiveOpen.OplockKey**, the operation MUST be failed with STATUS_OPLOCK_NOT_GRANTED.

  - Notify the server of an oplock break according to the algorithm in section 3.1.5.17.3, setting the algorithm's parameters as follows:

    - **BreakingOplockOpen** equal to **Open.Stream.Oplock.ExclusiveOpen**.

    - **NewOplockLevel** equal to **RequestedOplock**.

    - **AcknowledgeRequired** equal to FALSE.

    - **ReturnStatus** equal to STATUS_OPLOCK_SWITCHED_TO_NEW_HANDLE.

  - (The operation does not end at this point; this call to 3.1.5.17.3 completes some earlier call to 3.1.5.17.1.)

  - Set **Open.Stream.Oplock.ExclusiveOpen** to NULL.

  - Set *GrantExclusiveOplock* to TRUE.

- EndCase

- DefaultCase:

  - The operation MUST be failed with STATUS_OPLOCK_NOT_GRANTED.

- EndSwitch

- Else

  - The operation MUST be failed with STATUS_OPLOCK_NOT_GRANTED.

- EndIf

- If *GrantExclusiveOplock* is TRUE:

  - Set **Open.Stream.Oplock.ExclusiveOpen** equal to **Open**.

  - Set **Open.Stream.Oplock.State** equal to (**RequestedOplock**|EXCLUSIVE).

- This operation MUST be made cancelable by inserting it into **CancelableOperations.CancelableOperationList**.

- This operation waits until the oplock is broken or canceled, as specified in section 3.1.5.17.3.

- EndIf

### 3.1.5.17.2 Algorithm to Request a Shared Oplock

The inputs for requesting a shared oplock are:

- **Open:** The **Open** on which the oplock is being requested.

- **RequestedOplock:** The oplock type being requested.

- **GrantingInAck:** A Boolean value, TRUE if this oplock is being requested as part of an oplock break acknowledgement, FALSE if not.

The shared oplock request algorithm uses the following local variables:

- Boolean value (initialized to FALSE): *OplockGranted*

Pseudocode for the algorithm is as follows:

- If **Open.Stream.Oplock** is empty:

    - Build a new **Oplock** object with fields initialized as follows:

        - **Oplock.State** set to NO_OPLOCK.

        - All other fields set to 0/empty.

    - Store the new **Oplock** object in **Open.Stream.Oplock**.

- EndIf

- If (**GrantingInAck** is FALSE) and

    (**Open.Stream.Oplock.State** contains one or more of BREAK_TO_TWO, BREAK_TO_NONE, BREAK_TO_TWO_TO_NONE, BREAK_TO_READ_CACHING, BREAK_TO_WRITE_CACHING, BREAK_TO_HANDLE_CACHING, BREAK_TO_NO_CACHING, or EXCLUSIVE), then:

    - The operation MUST be failed with STATUS_OPLOCK_NOT_GRANTED.

- EndIf

- Switch (**RequestedOplock**):

    - Case LEVEL_TWO:

        - The operation MUST be failed with STATUS_OPLOCK_NOT_GRANTED if **Open.Stream.Oplock.State** is anything other than the following:

            - NO_OPLOCK

            - LEVEL_TWO_OPLOCK

            - READ_CACHING

- (LEVEL_TWO_OPLOCK|READ_CACHING)

- // Deliberate FALL-THROUGH to next Case statement.

- Case READ_CACHING:

  - The operation MUST be failed with STATUS_OPLOCK_NOT_GRANTED if **GrantingInAck** is FALSE and **Open.Stream.Oplock.State** is anything other than the following:

    - NO_OPLOCK

    - LEVEL_TWO_OPLOCK

    - READ_CACHING

    - (LEVEL_TWO_OPLOCK|READ_CACHING)

    - (READ_CACHING|HANDLE_CACHING)

    - (READ_CACHING|HANDLE_CACHING|MIXED_R_AND_RH)

    - (READ_CACHING|HANDLE_CACHING|BREAK_TO_READ_CACHING)

    - (READ_CACHING|HANDLE_CACHING|BREAK_TO_NO_CACHING)

  - If **GrantingInAck** is FALSE:

    - If there is an **Open** on **Open.Stream.Oplock.RHOplocks** whose **OplockKey** is equal to **Open.OplockKey**, the operation MUST be failed with STATUS_OPLOCK_NOT_GRANTED.

    - If there is an **Open** on **Open.Stream.Oplock.RHBreakQueue** whose **OplockKey** is equal to **Open.OplockKey**, the operation MUST be failed with STATUS_OPLOCK_NOT_GRANTED.

    - If there is an **Open** *ThisOpen* on **Open.Stream.Oplock.ROplocks** whose **OplockKey** is equal to **Open.OplockKey** (there should be at most one present):

      - Remove *ThisOpen* from **Open.Stream.Oplock.ROplocks**.

      - Notify the server of an oplock break according to the algorithm in section 3.1.5.17.3, setting the algorithm's parameters as follows:

        - **BreakingOplockOpen** equal to *ThisOpen*.

        - **NewOplockLevel** equal to READ_CACHING.

        - **AcknowledgeRequired** equal to FALSE.

        - **ReturnStatus** equal to STATUS_OPLOCK_SWITCHED_TO_NEW_HANDLE.

      - (The operation does not end at this point; this call to 3.1.5.17.3 completes some earlier call to 3.1.5.17.2.)

    - EndIf

  - EndIf

  - If **RequestedOplock** equals LEVEL_TWO:

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- Add **Open** to **Open.Stream.Oplock.IIOplocks**.

- Else // **RequestedOplock** equals READ_CACHING:

  - Add **Open** to **Open.Stream.Oplock.ROplocks**.

- EndIf

- Recompute **Open.Stream.Oplock.State** according to the algorithm in section [3.1.4.13](#), passing **Open.Stream.Oplock** as the **ThisOplock** parameter.

- Set *OplockGranted* to TRUE.

- EndCase

- Case (READ_CACHING|HANDLE_CACHING):

  - The operation MUST be failed with STATUS_OPLOCK_NOT_GRANTED if **GrantingInAck** is FALSE and **Open.Stream.Oplock.State** is anything other than the following:

    - NO_OPLOCK

    - READ_CACHING

    - (READ_CACHING|HANDLE_CACHING)

    - (READ_CACHING|HANDLE_CACHING|MIXED_R_AND_RH)

  - If **Open.Stream.IsDeleted** is TRUE, the operation MUST be failed with STATUS_OPLOCK_NOT_GRANTED.

  - If **GrantingInAck** is FALSE:

    - If there is an **Open** *ThisOpen* on **Open.Stream.Oplock.ROplocks** whose **OplockKey** is equal to **Open.OplockKey** (there should be at most one present):

      - Remove *ThisOpen* from **Open.Stream.Oplocks.ROplocks**.

        Notify the server of an oplock break according to the algorithm in section [3.1.5.17.3](#), setting the algorithm's parameters as follows:

        - **BreakingOplockOpen** equal to *ThisOpen*.

        - **NewOplockLevel** equal to (READ_CACHING|HANDLE_CACHING).

        - **AcknowledgeRequired** equal to FALSE.

        - **ReturnStatus** equal to STATUS_OPLOCK_SWITCHED_TO_NEW_HANDLE.

      - (The operation does not end at this point; this call to [3.1.5.17.3](#) completes some earlier call to [3.1.5.17.2](#).)

    - EndIf

    - If there is an **Open** *ThisOpen* on **Open.Stream.Oplock.RHOplocks** whose **OplockKey** is equal to **Open.OplockKey** (there should be at most one present):

      - Notify the server of an oplock break according to the algorithm in section [3.1.5.17.3](#), setting the algorithm's parameters as follows:

- **BreakingOplockOpen** equal to *ThisOpen*.

- **NewOplockLevel** equal to (READ_CACHING|HANDLE_CACHING).

- **AcknowledgeRequired** equal to FALSE.

- **ReturnStatus** equal to STATUS_OPLOCK_SWITCHED_TO_NEW_HANDLE.

- (The operation does not end at this point; this call to 3.1.5.17.3 completes some earlier call to 3.1.5.17.2.)

- EndIf

- EndIf

- Add **Open** to **Open.Stream.Oplock.RHOplocks**.

- Recompute **Open.Stream.Oplock.State** according to the algorithm in section 3.1.4.13, passing **Open.Stream.Oplock** as the **ThisOplock** parameter.

- Set *OplockGranted* to TRUE.

- EndCase

- // No other value of **RequestedOplock** is possible.

- EndSwitch

- If *OplockGranted* is TRUE:

- This operation MUST be made cancelable by inserting it into **CancelableOperations.CancelableOperationList**.

- The operation waits until the oplock is broken or canceled, as specified in section 3.1.5.17.3.

- EndIf

### 3.1.5.17.3   Indicating an Oplock Break to the Server

The inputs for indicating an oplock break to the server are:

- **BreakingOplockOpen:** The **Open** used to request the oplock that is now breaking.

- **NewOplockLevel:** The type of oplock the requested oplock has been broken to. Valid values are as follows:

- LEVEL_NONE (that is, no oplock)

- LEVEL_TWO

- A combination of one or more of the following flags:

- READ_CACHING

- HANDLE_CACHING

- WRITE_CACHING

- **AcknowledgeRequired:** A Boolean value; TRUE if the server MUST acknowledge the oplock break, FALSE if not, as specified in section 3.1.5.18.

- **ReturnStatus:** The NTSTATUS code to return to the server.

This algorithm simply represents the completion of an oplock request, as specified in section 3.1.5.17.1 or section 3.1.5.17.2. The server is expected to associate the return status from this algorithm with **BreakingOplockOpen**, which is the **Open** passed in when it requested the oplock that is now breaking.

It is important to note that because several oplocks may be outstanding in parallel, although this algorithm represents the completion of an oplock request, it may not result in the completion of the algorithm that called it. In particular, calling this algorithm will result in completion of the caller only if **BreakingOplockOpen** is the same as the **Open** with which the calling algorithm was itself called. To mitigate confusion, each algorithm that refers to this section will specify whether that algorithm's operation terminates at that point or not.

The object store MUST return **ReturnStatus**, **AcknowledgeRequired**, and **NewOplockLevel** to the server.

### 3.1.5.18  Server Acknowledges an Oplock Break

The server provides:

- **Open** - The **Open** associated with the oplock that has broken.

- **Type** - As part of the acknowledgement, the server indicates a new oplock it would like in place of the one that has broken. Valid values are as follows:

  - LEVEL_NONE

  - LEVEL_TWO

  - LEVEL_GRANULAR - If this oplock type is specified, the server additionally provides:

    - **RequestedOplockLevel** - A combination of zero or more of the following flags:

      - READ_CACHING

      - HANDLE_CACHING

      - WRITE_CACHING

If the server requests a new oplock and it is granted, the request does not complete until the oplock is broken; the operation waits for this to happen. Processing of an oplock break is described in section 3.1.5.17.3. Whether the new oplock is granted or not, the object store MUST return:

- **Status** - An NTSTATUS code indicating the result of the operation.

If the server requests a new oplock and it is granted, then when the oplock breaks and the request finally completes, the object store MUST additionally return:

- **NewOplockLevel:** The type of oplock the requested oplock has been broken to. Valid values are as follows:

  - LEVEL_NONE (that is, no oplock)

  - LEVEL_TWO

- A combination of one or more of the following flags:

  - READ_CACHING

  - HANDLE_CACHING

  - WRITE_CACHING

- **AcknowledgeRequired:** A Boolean value; TRUE if the server MUST acknowledge the oplock break, FALSE if not, as specified in section 3.1.5.17.2.

This routine uses the following local variables:

- Boolean values (initialized to FALSE): *NewOplockGranted*, *ReturnBreakToNone*, *FoundMatchingRHOplock*

Pseudocode for the operation is as follows:

- If **Open.Stream.Oplock** is empty, the operation MUST be failed with STATUS_INVALID_OPLOCK_PROTOCOL.

- If **Type** is LEVEL_NONE or LEVEL_TWO:

  - If **Open.Stream.Oplock.ExclusiveOpen** is not equal to **Open**, the operation MUST be failed with STATUS_INVALID_OPLOCK_PROTOCOL.

  - If **Type** is LEVEL_TWO and **Open.Stream.Oplock.State** contains BREAK_TO_TWO:

    - Set **Open.Stream.Oplock.State** to LEVEL_TWO_OPLOCK.

    - Set *NewOplockGranted* to TRUE.

  - Else If **Open.Stream.Oplock.State** contains BREAK_TO_TWO or BREAK_TO_NONE:

    - Set **Open.Stream.Oplock.State** to NO_OPLOCK.

  - Else If **Open.Stream.Oplock.State** contains BREAK_TO_TWO_TO_NONE:

    - Set **Open.Stream.Oplock.State** to NO_OPLOCK.

    - Set *ReturnBreakToNone* to TRUE.

  - Else

    - The operation MUST be failed with STATUS_INVALID_OPLOCK_PROTOCOL.

  - EndIf

  - For each **Open** *WaitingOpen* on **Open.Stream.Oplock.WaitList**:

    - Indicate that the operation associated with *WaitingOpen* may continue according to the algorithm in section 3.1.4.12.1, setting **OpenToRelease** equal to *WaitingOpen*.

    - Remove *WaitingOpen* from **Open.Stream.Oplock.WaitList**.

  - EndFor

  - Set **Open.Stream.Oplock.ExclusiveOpen** to NULL.

- If *NewOplockGranted* is TRUE:

    - The operation waits until the newly-granted Level 2 oplock is broken, as specified in section [3.1.5.17.3](#).

- Else If *ReturnBreakToNone* is TRUE:

    - In this case the server was expecting the oplock to break to Level 2, but because the oplock is actually breaking to None (that is, no oplock), the object store MUST indicate an oplock break to the server according to the algorithm in section [3.1.5.17.3](#), setting the algorithm's parameters as follows:

        - **BreakingOplockOpen** equal to **Open**.

        - **NewOplockLevel** equal to LEVEL_NONE.

        - **AcknowledgeRequired** equal to FALSE.

        - **ReturnStatus** equal to STATUS_SUCCESS.

    - (Because **BreakingOplockOpen** is equal to the passed-in **Open**, the operation ends at this point.)

- Else

    - The operation MUST return STATUS_SUCCESS at this point.

- EndIf

- Else If **Type** is LEVEL_GRANULAR:

    - Let *BREAK_LEVEL_MASK* = (BREAK_TO_READ_CACHING | BREAK_TO_WRITE_CACHING | BREAK_TO_HANDLE_CACHING | BREAK_TO_NO_CACHING)

    - Let *R_AND_RH_GRANTED* = (READ_CACHING|HANDLE_CACHING|MIXED_R_AND_RH)

    - Let *RH_GRANTED* = (READ_CACHING|HANDLE_CACHING)

    - // If there are no *BREAK_LEVEL_MASK* flags set, this is invalid, unless the

    - // state is *R_AND_RH_GRANTED* or *RH_GRANTED*, in which case we'll need to see if

    - // the **RHBreakQueue** is empty.

    - If (**Open.Stream.Oplock.State** does not contain any flag in *BREAK_LEVEL_MASK* and

        (**Open.Stream.Oplock.State** != *R_AND_RH_GRANTED*) and

        (**Open.Stream.Oplock.State** != *RH_GRANTED*)) or

        (((**Open.Stream.Oplock.State** == *R_AND_RH_GRANTED*) or

        (**Open.Stream.Oplock.State** == *RH_GRANTED*)) and

        **Open.Stream.Oplock.RHBreakQueue** is empty):

        - The request MUST be failed with STATUS_INVALID_OPLOCK_PROTOCOL.

    - EndIf

- Switch **Open.Stream.Oplock.State**

  - Case (READ_CACHING|HANDLE_CACHING|MIXED_R_AND_RH):

  - Case (READ_CACHING|HANDLE_CACHING):

  - Case (READ_CACHING|HANDLE_CACHING|BREAK_TO_READ_CACHING):

  - Case (READ_CACHING|HANDLE_CACHING|BREAK_TO_NO_CACHING):

    - For each **RHOpContext** *ThisContext* in **Open.Stream.Oplock.RHBreakQueue**:

      - If *ThisContext*.**Open** equals **Open**:

        - Set *FoundMatchingRHOplock* to TRUE.

        - If *ThisContext*.**BreakingToRead** is FALSE:

          - If **RequestedOplockLevel** is not 0 and

**Open.Stream.Oplock.WaitList** is not empty:

          - The object store MUST indicate an oplock break to the server according to the algorithm in section 3.1.5.17.3, setting the algorithm's parameters as follows:

            - **BreakingOplockOpen** equal to **Open**.

            - **NewOplockLevel** equal to LEVEL_NONE.

            - **AcknowledgeRequired** equal to TRUE.

            - **ReturnStatus** equal to STATUS_CANNOT_GRANT_REQUESTED_OPLOCK.

          - (Because **BreakingOplockOpen** is equal to the passed-in **Open**, the operation ends at this point.)

        - EndIf

      - Else // *ThisContext*.**BreakingToRead** is TRUE.

        - If **Open.Stream.Oplock.WaitList** is not empty and

(**RequestedOplockLevel** is (READ_CACHING|WRITE_CACHING) or (READ_CACHING|WRITE_CACHING|HANDLE_CACHING)):

          - The object store MUST indicate an oplock break to the server according to the algorithm in section 3.1.5.17.3, setting the algorithm's parameters as follows:

            - **BreakingOplockOpen** equal to **Open**.

            - **NewOplockLevel** equal to READ_CACHING.

            - **AcknowledgeRequired** equal to TRUE.

            - **ReturnStatus** equal to STATUS_CANNOT_GRANT_REQUESTED_OPLOCK.

- (Because **BreakingOplockOpen** is equal to the passed-in **Open**, the operation ends at this point.)

- EndIf

- EndIf

- Remove *ThisContext* from **Open.Stream.Oplock.RHBreakQueue**.

- For each **Open** *WaitingOpen* on **Open.Stream.Oplock.WaitList**:

  - // The operation waiting for the Read-Handle oplock to break may continue if

  - // there are no more Read-Handle oplocks outstanding, or if all the remaining

  - // Read-Handle oplocks have the same oplock key as the waiting operation.

  - If (**Open.Stream.Oplock.RHBreakQueue** is empty) or

(all **RHOpContext.Open.OplockKey** values on **Open.Stream.Oplock.RHBreakQueue** are equal to *WaitingOpen*.**OplockKey**):

  - Indicate that the operation associated with *WaitingOpen* may continue according to the algorithm in section 3.1.4.12.1, setting **OpenToRelease** equal to *WaitingOpen*.

    - Remove *WaitingOpen* from **Open.Stream.Oplock.WaitList**.

  - EndIf

- EndFor

- If **RequestedOplockLevel** is 0 (that is, no flags):

  - Recompute **Open.Stream.Oplock.State** according to the algorithm in section 3.1.4.13, passing **Open.Stream.Oplock** as the **ThisOplock** parameter.

  - The algorithm MUST return STATUS_SUCCESS at this point.

- Else If **RequestedOplockLevel** does not contain WRITE_CACHING:

  - The object store MUST request a shared oplock according to the algorithm in section 3.1.5.17.2, setting the algorithm's parameters as follows:

    - Pass in the current **Open**.

    - **RequestedOplock** equal to **RequestedOplockLevel**.

    - **GrantingInAck** equal to TRUE.

  - The operation MUST at this point return any status code returned by the shared oplock request algorithm.

- Else

  - Set **Open.Stream.Oplock.ExclusiveOpen** to *ThisContext*.**Open**.

  - Set **Open.Stream.Oplock.State** to (**RequestedOplockLevel**|EXCLUSIVE).

- - - This operation MUST be made cancelable by inserting it into **CancelableOperations.CancelableOperationList**.

    - This operation waits until the oplock is broken or canceled, as specified in section [3.1.5.17.3](#).

  - - EndIf

  - - Break out of the For loop.

  - - EndIf

- - EndFor

- - If *FoundMatchingRHOplock* is FALSE:

  - - The operation MUST be failed with STATUS_INVALID_OPLOCK_PROTOCOL.

- - EndIf

- - The operation returns STATUS_SUCCESS at this point.

- EndCase

- Case (READ_CACHING|WRITE_CACHING|EXCLUSIVE|BREAK_TO_READ_CACHING):

- Case (READ_CACHING|WRITE_CACHING|EXCLUSIVE|BREAK_TO_NO_CACHING):

- Case (READ_CACHING|WRITE_CACHING|HANDLE_CACHING|EXCLUSIVE|BREAK_TO_READ_CACHING|BREAK_TO_WRITE_CACHING):

- Case (READ_CACHING|WRITE_CACHING|HANDLE_CACHING|EXCLUSIVE|BREAK_TO_READ_CACHING|BREAK_TO_HANDLE_CACHING):

- Case (READ_CACHING|WRITE_CACHING|HANDLE_CACHING|EXCLUSIVE|BREAK_TO_READ_CACHING):

- Case (READ_CACHING|WRITE_CACHING|HANDLE_CACHING|EXCLUSIVE|BREAK_TO_NO_CACHING):

  - If **Open.Stream.Oplock.ExclusiveOpen** != **Open**:

    - The operation MUST be failed with STATUS_INVALID_OPLOCK_PROTOCOL.

  - EndIf

  - If **Open.Stream.Oplock.WaitList** is not empty and

    **Open.Stream.Oplock.State** does not contain HANDLE_CACHING and

    **RequestedOplockLevel** is (READ_CACHING|WRITE_CACHING|HANDLE_CACHING):

    - The object store MUST indicate an oplock break to the server according to the algorithm in section [3.1.5.17.3](#), setting the algorithm's parameters as follows:

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- **BreakingOplockOpen** equal to **Open**.

- **NewOplockLevel** equal to:

  - (READ_CACHING|WRITE_CACHING) if **Open.Stream.Oplock.State** contains each of BREAK_TO_READ_CACHING and BREAK_TO_WRITE_CACHING and not BREAK_TO_HANDLE_CACHING.

  - (READ_CACHING|HANDLE_CACHING) if **Open.Stream.Oplock.State** contains each of BREAK_TO_READ_CACHING and BREAK_TO_HANDLE_CACHING and not BREAK_TO_WRITE_CACHING.

  - READ_CACHING if **Open.Stream.Oplock.State** contains BREAK_TO_READ_CACHING and neither BREAK_TO_WRITE_CACHING nor BREAK_TO_HANDLE_CACHING.

  - LEVEL_NONE if **Open.Stream.Oplock.State** contains BREAK_TO_NO_CACHING.

- **AcknowledgeRequired** equal to TRUE.

- **ReturnStatus** equal to STATUS_CANNOT_GRANT_REQUESTED_OPLOCK.

- (Because **BreakingOplockOpen** is equal to the passed-in **Open**, the operation ends at this point.)

- Else

  - If **Open.Stream.IsDeleted** is TRUE and **RequestedOplockLevel** contains HANDLE_CACHING:

    - The object store MUST indicate an oplock break to the server according to the algorithm in section 3.1.5.17.3, setting the algorithm's parameters as follows:

      - **BreakingOplockOpen** equal to **Open**.

      - **NewOplockLevel** equal to **RequestedOplockLevel** without HANDLE_CACHING (for example if **RequestedOplockLevel** is (READ_CACHING|HANDLE_CACHING), then **NewOplockLevel** would be just READ_CACHING).

      - **AcknowledgeRequired** equal to TRUE.

      - **ReturnStatus** equal to STATUS_CANNOT_GRANT_REQUESTED_OPLOCK.

    - (Because **BreakingOplockOpen** is equal to the passed-in **Open**, the operation ends at this point.)

  - EndIf

  - For each **Open** *WaitingOpen* on **Open.Stream.Oplock.WaitList**:

    - Indicate that the operation associated with *WaitingOpen* may continue according to the algorithm in section 3.1.4.12.1, setting **OpenToRelease** equal to *WaitingOpen*.

    - Remove *WaitingOpen* from **Open.Stream.Oplock.WaitList**.

- EndFor

- If **RequestedOplockLevel** does not contain WRITE_CACHING:

  - Set **Open.Stream.Oplock.ExclusiveOpen** to NULL.

- EndIf

- If **RequestedOplockLevel** is 0 (that is, no flags):

  - Set **Open.Stream.Oplock.State** to NO_OPLOCK.

  - The operation returns STATUS_SUCCESS at this point.

- Else If **RequestedOplockLevel** does not contain WRITE_CACHING:

  - The object store MUST request a shared oplock according to the algorithm in section 3.1.5.17.2, setting the algorithm's parameters as follows:

    - Pass in the current **Open**.

    - **RequestedOplock** equal to **RequestedOplockLevel**.

    - **GrantingInAck** equal to TRUE.

  - The operation MUST at this point return any status code returned by the shared oplock request algorithm.

- Else

  - // Note that because this oplock is being set up as part of an acknowledgement

  - // of an exclusive oplock break, **Open.Stream.Oplock.ExclusiveOpen** was set

  - // at the time of the original oplock request; it contains **Open**.

  - Set **Open.Stream.Oplock.State** to (**RequestedOplockLevel**|EXCLUSIVE).

  - This operation MUST be made cancelable by inserting it into **CancelableOperations.CancelableOperationList**.

- This operation waits until the oplock is broken or canceled, as specified in section 3.1.5.17.3.

- EndIf

- EndCase

- DefaultCase:

  - The operation MUST be failed with STATUS_INVALID_OPLOCK_PROTOCOL.

- EndSwitch

- EndIf

### 3.1.5.19 Server Requests Canceling an Operation

The server provides:

- **IORequest:** An implementation-specific identifier that is unique for each outstanding IO operation, as described in [MS-CIFS] section 3.3.5.52.

No information is returned.

Cancelation provides the ability for operations that block for extended periods of time to be terminated, thus providing better end-user responsiveness. How operation cancelation is implemented is object store specific.

The Object Store MUST maintain a list of waiting operations that can be canceled by adding them to the **CancelableOperations.CancelableOperationList** as defined in section 3.1.1.12.

Each operation receives an implementation-specific identifier (**IORequest**) that uniquely identifies an in-progress I/O operation, as specified in section 3.1.5.

When a cancelation request is received, scan **CancelableOperations.CancelableOperationList** looking for an operation *CanceledOperation* that matches **IORequest**. If found, *CanceledOperation* MUST be removed from **CancelableOperations.CancelableOperationList** and *CanceledOperation* MUST be failed with STATUS_CANCELED returned for the status of the canceled operation. If not found, the cancel request returns performing no action.<67>

### 3.1.5.20 Server Requests Querying Quota Information

The server provides:

- **Open:** An Open of a Quota Stream<68>

- **OutputBufferSize:** The maximum number of bytes to return in **OutputBuffer**.

- **ReturnSingleEntry:** A **Boolean** that, if TRUE, indicates at most one entry MUST be returned. If FALSE, one or more entries MAY be returned, up to what will fit in **OutputBufferSize** bytes.

- **SidList:** An optional array of one or more FILE_GET_QUOTA_INFORMATION structures as specified in [MS-FSCC] section 2.4.33.1. This identifies the **SIDs** whose quota information is to be returned.

- **SidListLength:** The length, in bytes, of the **SidList** array. If no **SidList** array is provided, this MUST be set to zero.

- **StartSid:** An optional SID identifying the entry at which to begin scanning quota information. This parameter is ignored if the **SidList** parameter is specified. If no **StartSid** SID is provided, this field is empty.

- **RestartScan:** A **Boolean** that, if TRUE, indicates that enumeration should be restarted from the beginning of the quota list. If FALSE, enumeration should continue from the last position.

On completion, the object store MUST return:

- **Status:** An **NTSTATUS** code that specifies the result.

- **OutputBuffer:** An array of one or more FILE_QUOTA_INFORMATION structures as specified in [MS-FSCC] section 2.4.33.

- **ByteCount:** The number of bytes stored in **OutputBuffer**.

Support for this operation is optional. If the object store does not implement this functionality, the operation MUST be failed with STATUS_INVALID_DEVICE_REQUEST.

Pseudocode for the operation is as follows:

- If **SidList** is not empty and **SidListLength** is not a multiple of 4, the operation MUST be failed with STATUS_INVALID_PARAMETER.

- If **SidListLength** is not zero but less than *sizeof*(FILE_GET_QUOTA_INFORMATION), **SidList** will be zero filled up to *sizeof*(FILE_GET_QUOTA_INFORMATION).

- If **SidList** is not empty:

  - For each entry in **SidList**, the object store MUST return a FILE_QUOTA_INFORMATION structure as specified in [MS-FSCC] section 2.4.33, where the data returned is from the **Open.Volume.QuotaInformation** entry with the same SID.

  - If **SidList** includes a SID that does not map to an existing SID in the **Open.Volume.QuotaInformation** list, the object store MUST return a FILE_QUOTA_INFORMATION structure (as specified in [MS-FSCC] section 2.4.33) that is filled with zeros.

  - If **ReturnSingleEntry** is TRUE, the object store MUST return information only on the first SID in **SidList**. No other **SidList** entries other than the first are processed by the object store.

  - **RestartScan** and **StartSid** are ignored.

- Else: // **SidList** is empty

  - If **OutputBufferSize** is less than *sizeof*(FILE_QUOTA_INFORMATION), the operation MUST be failed with STATUS_BUFFER_TOO_SMALL.

  - If **StartSid** is not empty:

    - If **StartSid** is not found in **Open.Volume.QuotaInformation** then the operation MUST be failed with STATUS_INVALID_PARAMETER.

    - Set **Open.LastQuotaId** to the index of the entry in **Open.Volume.QuotaInformation** that matches **StartSid**.

    - **RestartScan** is ignored.

  - Else:

    - If **RestartScan** is TRUE or **Open.LastQuotaId** is -1:

      - Set **Open.LastQuotaId** to the index of the first entry in the **Open.Volume.QuotaInformation** list.

    - Else:

      - Set **Open.LastQuotaId** to the index of the entry after the current value of **Open.LastQuotaId** of **Open.Volume.QuotaInformation** list.

    - EndIf

  - EndIf

  - The object store MUST return a FILE_QUOTA_INFORMATION structure (as specified in [MS-FSCC] section 2.4.33) that corresponds to the entry in **Open.Volume.QuotaInformationList** that has the index specified by **Open.LastQuotaId**.

- If **ReturnSingleEntry** is TRUE, the object store MUST return information on only a single quota entry.

- If **ReturnSingleEntry** is FALSE and **Open.LastQuotaId** is not at the end of the **Open.Volume.QuotaInformation** list and more FILE_QUOTA_INFORMATION structures will fit in the remaining **ByteCount**, then more FILE_QUOTA_INFORMATION structures SHOULD be returned until either **Open.LastQuotaId** is at the end of **Open.Volume.QuotaInformation** list or no more FILE_QUOTA_INFORMATION structures will fit in **OutputBuffer**.

  - The operation MUST fail with STATUS_NO_MORE_ENTRIES when no entries are returned.

  - **Open.LastQuotaId** MUST be set to point to the entry in **Open.Volume.QuotaInformation** that represents the last returned FILE_QUOTA_INFORMATION structure in **OutputBuffer**.

- EndIf

- Upon successful completion, the object store MUST return:

  - **Status** set to STATUS_SUCCESS.

  - **ByteCount** set to the count, in bytes, of how much data was filled into **OutputBuffer**.

### 3.1.5.21  Server Requests Setting Quota Information

The server provides:

- **Open:** An **Open** of a Quota Stream<69>.

- **InputBuffer:** A buffer that contains one or more aligned FILE_QUOTA_INFORMATION structures as defined in [MS-FSCC] section 2.4.33.

- **InputBufferSize:** The size, in bytes, of **InputBuffer**.

On completion, the object store MUST return:

- **Status:** An **NTSTATUS** code that specifies the result.

Support for this operation is optional. If the object store does not implement this functionality, the operation MUST be failed with STATUS_INVALID_DEVICE_REQUEST.

Pseudocode for the operation is as follows:

- If **InputBufferSize** is zero, the operation MUST be failed with STATUS_INVALID_PARAMETER.

- For each FILE_QUOTA_INFORMATION structure *quota* in **InputBuffer:**

  - Scan **Open.Volume.QuotaInformation** for an entry that matches *quota*.**Sid** and if found, save a pointer in *matchedQuota*; else set *matchedQuota* to empty.

  - If *quota*.**Sid** == BUILTIN_ADMINISTRATORS (as defined in [MS-DTYP] section 2.4.2.4) and *quota*.**QuotaLimit** != -1, the operation MUST be failed with STATUS_ACCESS_DENIED.  A quota limit cannot be specified on the administrators account.

  - If *quota*.**QuotaLimit** == -2 //The quota is being deleted

    - If *matchedQuota* is not empty:

- - Remove *matchedQuota* from **Open.Volume.QuotaInformation** and delete it.

    - Set *matchedQuota* to empty.

  - Else

    - The operation MUST be failed with STATUS_NO_MATCH

  - Endif

- Else if *matchedQuota* is not empty:

  - Set *matchedQuota*.**QuotaThreshold** to *quota*.**QuotaThreshold**.

  - Set *matchedQuota*.**QuotaLimit** to *quota*.**QuotaLimit**.

  - Set *matchedQuota*.**ChangeTime** to the current time.

- Else: *//matchedQuota* is empty:

  - Set *matchedQuota* to a newly allocated FILE_QUOTA_INFORMATION structure.

  - Set *matchedQuota*.**Sid** to *quota*.**Sid**.

  - Set *matchedQuota*.**SidLength** to the length of *quota*.**Sid.**

  - Set *matchedQuota*.**QuotaThreshold** to *quota*.**QuotaThreshold**.

  - Set *matchedQuota*.**QuotaLimit** to *quota*.**QuotaLimit**.

  - Set *matchedQuota*.**ChangeTime** to the current time.

  - Insert *matchedQuota* into **Volume.QuotaInformation**.

  - *matchedQuota*.**QuotaUsed** should be updated in the background by scanning all files in **Open.Volume** where **File.SecurityDescriptor.Owner** == *matchedQuota*.**Sid**.

- EndIf

- Upon successful completion, the object store MUST return:

  - **Status** set to STATUS_SUCCESS.

# 4   Protocol Examples

None.

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# 5   Security

## 5.1   Security Considerations for Implementers

Security is opaque to file systems. Some file systems store security descriptors as opaque blobs and then call security support routines to perform the necessary security checks. Other file systems do not implement security. Security considerations are called out in the sections where they are used. Please refer to [MS-SECO] for a security overview.

## 5.2   Index of Security Parameters

| Security parameter | Section |
|---|---|
| SecurityContext | 3.1.4.13 |
| SecurityDescriptor | 3.1.4.13 |
| SecurityContext | 3.1.5.1 |
| SecurityInformation | 3.1.5.13 |
| SecurityInformation | 3.1.5.16 |

# 6 Appendix A: Product Behavior

The information in this specification is applicable to the following Microsoft products or supplemental software. References to product versions include released service packs:

- Microsoft Windows® 2000 operating system

- Windows® XP operating system

- Windows Server® 2003 operating system

- Windows Vista® operating system

- Windows Server® 2008 operating system

- Windows® 7 operating system

- Windows Server® 2008 R2 operating system

Exceptions, if any, are noted below. If a service pack or Quick Fix Engineering (QFE) number appears with the product version, behavior changed in that service pack or QFE. The new behavior also applies to subsequent service packs of the product unless otherwise specified. If a product edition appears with the product version, behavior is different in that product edition.

Unless otherwise specified, any statement of optional behavior in this specification that is prescribed using the terms SHOULD or SHOULD NOT implies product behavior in accordance with the SHOULD or SHOULD NOT prescription. Unless otherwise specified, the term MAY implies that the product does not follow the prescription.

<1> Section 1.1: Of the standard Windows file systems, only the UDFS file system supports Software Defect Management.

<2> Section 3.1.1.1: NTFS uses a default cluster size of 4k, a maximum cluster size of 64k, and a minimum cluster size of 512 bytes.

<3> Section 3.1.1.1: In NTFS, the CompressionUnitSize is 64K for encrypted files, 64K for sparse files, and the lesser of 64K or (16 * ClusterSize) for compressed files. Other file systems do not implement this field.

<4> Section 3.1.1.1: In NTFS, the CompressedChunkSize is 4K. Other Windows file systems do not implement this field.

<5> Section 3.1.1.1: This field is present for compatibility with the file level FileObjectIdInformation structure ([MS-FSCC] section 2.4.28). These fields are not currently used by Windows and always contain zeroes.

<6> Section 3.1.1.1: The USN journal is supported on NTFS version 3.0 volumes or greater. The USN journal is active by default on Windows client SKUs starting with Windows Vista and later. The USN journal is not active by default on Windows Server SKUs.

<7> Section 3.1.1.3: The following table defines the support of file time stamps across various Windows file systems. More information can be found in section 6 of the File System Behavior Overview document [FSBO].

| Timestamp | NTFS | FAT | EXFAT | UDFS |
|---|---|---|---|---|
| CreationTime | Stored in UTC<br>100 nanosecond granularity | Stored in local time<br>10 millisecond granularity | Stored in UTC if available, else in local time<br>10 millisecond granularity | Stored in UTC if available, else in local time<br>1 microsecond granularity |
| LastAccessTime | Stored in UTC<br>100 nanosecond granularity<br>Updated at 60 minute granularity | Stored in local time<br>1 day granularity | Stored in UTC if available, else in local time<br>2 second granularity | Stored in UTC if available, else in local time<br>1 microsecond granularity |
| ChangeTime | Stored in UTC<br>100 nanosecond granularity | Not Supported | Not Supported | Stored in UTC if available, else in local time<br>1 microsecond granularity |
| LastWriteTime | Stored in UTC<br>100 nanosecond granularity | Stored in local time<br>2 second granularity | Stored in UTC if available, else in local time<br>10 millisecond granularity | Stored in UTC if available, else in local time<br>1 microsecond granularity |

<8> Section 3.1.1.3: The following table defines the support of file time stamps across various Windows file systems. More information can be found in section 6 of the File System Behavior Overview document [FSBO].

| Timestamp | NTFS | FAT | EXFAT | UDFS |
|---|---|---|---|---|
| CreationTime | Stored in UTC<br>100 nanosecond granularity | Stored in local time<br>10 millisecond granularity | Stored in UTC if available, else in local time<br>10 millisecond granularity | Stored in UTC if available, else in local time<br>1 microsecond granularity |
| LastAccessTime | Stored in UTC<br>100 nanosecond granularity<br>Updated at 60 minute granularity | Stored in local time<br>1 day granularity | Stored in UTC if available, else in local time<br>2 second granularity | Stored in UTC if available, else in local time<br>1 microsecond granularity |
| ChangeTime | Stored in UTC<br>100 nanosecond granularity | Not Supported | Not Supported | Stored in UTC if available, else in local time<br>1 microsecond granularity |
| LastWriteTime | Stored in UTC<br>100 nanosecond granularity | Stored in local time<br>2 second granularity | Stored in UTC if available, else in local time<br>10 millisecond granularity | Stored in UTC if available, else in local time<br>1 microsecond granularity |

<9> Section 3.1.1.3: The following table defines the support of file time stamps across various Windows file systems. More information can be found in section 6 of the File System Behavior Overview document [FSBO].

| Timestamp | NTFS | FAT | EXFAT | UDFS |
|---|---|---|---|---|
| CreationTime | Stored in UTC<br>100 nanosecond granularity | Stored in local time<br>10 millisecond granularity | Stored in UTC if available, else in local time<br>10 millisecond granularity | Stored in UTC if available, else in local time<br>1 microsecond granularity |
| LastAccessTime | Stored in UTC<br>100 nanosecond granularity<br>Updated at 60 minute granularity | Stored in local time<br>1 day granularity | Stored in UTC if available, else in local time<br>2 second granularity | Stored in UTC if available, else in local time<br>1 microsecond granularity |
| ChangeTime | Stored in UTC<br>100 nanosecond granularity | Not Supported | Not Supported | Stored in UTC if available, else in local time<br>1 microsecond granularity |
| LastWriteTime | Stored in UTC<br>100 nanosecond granularity | Stored in local time<br>2 second granularity | Stored in UTC if available, else in local time<br>10 millisecond granularity | Stored in UTC if available, else in local time<br>1 microsecond granularity |

<10> Section 3.1.1.3: In Windows Vista/Windows Server 2008 and later, LastAccessTime updates are disabled by default in the NTFS file system. It is only updated when the file is closed. This behavior is controlled by the following registry key: HKLM\System\CurrentControlSet\Control\FileSystem\NtfsDisableLastAccessUpdate. A nonzero value means LastAccessTime updates are disabled. A value of zero means they are enabled.

<11> Section 3.1.1.3: The following table defines the support of file time stamps across various Windows file systems. More information can be found in section 6 of the File System Behavior Overview document [FSBO].

| Timestamp | NTFS | FAT | EXFAT | UDFS |
|---|---|---|---|---|
| CreationTime | Stored in UTC<br>100 nanosecond granularity | Stored in local time<br>10 millisecond granularity | Stored in UTC if available, else in local time<br>10 millisecond granularity | Stored in UTC if available, else in local time<br>1 microsecond granularity |
| LastAccessTime | Stored in UTC<br>100 nanosecond granularity<br>Updated at 60 minute granularity | Stored in local time<br>1 day granularity | Stored in UTC if available, else in local time<br>2 second granularity | Stored in UTC if available, else in local time<br>1 microsecond granularity |
| ChangeTime | Stored in UTC | Not Supported | Not Supported | Stored in UTC if |

| Timestamp | NTFS | FAT | EXFAT | UDFS |
|---|---|---|---|---|
| | 100 nanosecond granularity | | | available, else in local time<br><br>1 microsecond granularity |
| LastWriteTime | Stored in UTC<br><br>100 nanosecond granularity | Stored in local time<br><br>2 second granularity | Stored in UTC if available, else in local time<br><br>10 millisecond granularity | Stored in UTC if available, else in local time<br><br>1 microsecond granularity |

<12> Section 3.1.5.5.1: This directory is only available on NTFS volumes formatted to NTFS version 3.0 or late.

<13> Section 3.1.5.5.1: "*" is treated as 0x0000002A during the search, and it gives the practical behavior of a wildcard since an ObjectId starts with a much larger value. Similarly, "?" is treated as 0x0000003F and so practically it behaves like "*".

<14> Section 3.1.5.5.2: This directory is only available on NTFS volumes formatted to NTFS version 3.0 or later.

<15> Section 3.1.5.6: This is only implemented by the NTFS file system. Other file systems return STATUS_SUCCESS and perform no other action.

<16> Section 3.1.5.9.1: This is only implemented by the NTFS file system.

<17> Section 3.1.5.9.1: If the generated ObjectId collides with existing ObjectIds on the volume, Windows retries up to 16 times before failing the operation with STATUS_DUPLICATE_NAME.

<18> Section 3.1.5.9.1: The file system only updates LastChangeTime if no user has explicitly set LastChangeTime. Some Windows file systems defer setting the LastChangeTime until the handle is closed.

<19> Section 3.1.5.9.2: This is only implemented by the NTFS file system.

<20> Section 3.1.5.9.2: The file system only updates LastChangeTime if no user has explicitly set LastChangeTime. Some Windows file systems defer setting the LastChangeTime until the handle is closed.

<21> Section 3.1.5.9.3: This is only implemented by the NTFS file system.

<22> Section 3.1.5.9.3: The file system only updates LastChangeTime if no user has explicitly set LastChangeTime. Some Windows file systems defer setting the LastChangeTime until the handle is closed.

<23> Section 3.1.5.9.4: This is only implemented by the NTFS, FAT, and exFAT file system.

<24> Section 3.1.5.9.4: The NTFS file system sets an NTFS_STATISTICS structure as specified in [MS-FSCC] section 2.3.8.2. The FAT file system sets a FAT_STATISTICS structure as specified in [MS-FSCC] section 2.3.8.3. The EXFAT file system sets a EXFAT_STATISTICS structure as specified in [MS-FSCC] section 2.3.8.4.

<25> Section 3.1.5.9.5: This is only implemented by the NTFS file system.

<26> Section 3.1.5.9.6: This is only implemented by the NTFS file system.

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<27> Section 3.1.5.9.7: This is only implemented by the NTFS file system.

<28> Section 3.1.5.9.7: Several of the fields being set in this section are specific to how the NTFS file system is implemented and are not defined in the Object Stores Abstract Data Model.

<29> Section 3.1.5.9.8: This is only implemented by the NTFS file system.

<30> Section 3.1.5.9.9: This is only implemented by the NTFS file system.

<31> Section 3.1.5.9.14: Support for this FSCTL is only implemented in the FAT file system. The data returned by this FSCTL is incomplete and incorrect on FAT32, and it is unsupported on all other file systems, as specified in [MS-FSCC] section 2.3.35.

<32> Section 3.1.5.9.14: This operation is only supported by the FAT file system.

<33> Section 3.1.5.9.15: This is only implemented by the NTFS file system.

<34> Section 3.1.5.9.16: This is only implemented by the UDFS file system.

<35> Section 3.1.5.9.17: This is only implemented by the UDFS file system.

<36> Section 3.1.5.9.18: This is only implemented by the NTFS file system.

<37> Section 3.1.5.9.19: This file system request is handled by the optional hierarchical storage management (HSM) file system filter. This filter has been deprecated as of Windows Server 2008 and is a server-only feature.

<38> Section 3.1.5.9.20: This is only implemented by the NTFS file system.

<39> Section 3.1.5.9.20: NTFS File Compression can be disabled globally on a system by setting the registry key HKLM\SYSTEM\CurrentControlSet\Control\FileSystem\NtfsDisableCompression to 1 and then rebooting the system to have the change take effect. Compression can be re-enabled by setting this key to zero and rebooting the system.

<40> Section 3.1.5.9.21: This is only implemented by the UDFS file system on media types that require software defect management.

<41> Section 3.1.5.9.22: This is only implemented by the NTFS file system.

<42> Section 3.1.5.9.23: This is only implemented by the NTFS file system.

<43> Section 3.1.5.9.23: The file system only updates LastChangeTime if no user has explicitly set LastChangeTime. Some Windows file systems defer setting the LastChangeTime until the handle is closed.

<44> Section 3.1.5.9.24: This is only implemented by the NTFS file system.

<45> Section 3.1.5.9.24: The file system only updates LastChangeTime if no user has explicitly set LastChangeTime. Some Windows file systems defer setting the LastChangeTime until the handle is closed.

<46> Section 3.1.5.9.25: This is only implemented by the NTFS file system.

<47> Section 3.1.5.9.25: The file system only updates LastChangeTime if no user has explicitly set LastChangeTime. Some Windows file systems defer setting the LastChangeTime until the handle is closed.

<48> Section 3.1.5.9.26: WinPE stands for the Windows Preinstallation Environment. For more information please see: http://technet.microsoft.com/en-us/library/cc766093(WS.10).aspx

<49> Section 3.1.5.9.27: This is only implemented by the NTFS file system.

<50> Section 3.1.5.9.28: This is only implemented by the NTFS file system.

<51> Section 3.1.5.9.29: This is only implemented by the NTFS file system.

<52> Section 3.1.5.9.30: [SIS] (Single Instance Storage) is an optional feature available in the following versions of Windows Server: Windows Storage Server 2003 R2, Standard Edition, Windows Storage Server 2008, and Windows Storage Server 2008 R2. [SIS] is not supported directly by an of the Windows file systems but is implemented as a file system filter. Please refer to the following article for detailed information about [SIS].

<53> Section 3.1.5.9.30: In the Windows environment file system are implemented in kernel mode. If a NULL security context is specified and the originator of the operation is running in kernel mode, a built-in SYSTEM security context is used that grants all access.

<54> Section 3.1.5.9.30: In the Windows environment file system are implemented in kernel mode. If a NULL security context is specified and the originator of the operation is running in kernel mode, a built-in SYSTEM security context is used that grants all access.

<55> Section 3.1.5.9.30: In the Windows environment this is done by creating a new file in what is known as the "SIS Common Store". Reparse points are attached to any file controlled by [SIS] that contains information on how to access the Common Store file that contains the data for this file. Please see the following article about [SIS] for details on how this is implemented.

<56> Section 3.1.5.9.31: This is only implemented by the NTFS file system.

<57> Section 3.1.5.11.23: If **Open.Mode** contains neither FILE_SYNCHRONOUS_IO_ALERT nor FILE_SYNCHRONOUS_IO_NONALERT, this operation does not return meaningful information in **OutputBuffer.CurrentByteOffset**, because **Open.CurrentByteOffset** is not maintained for any **Open** that does not have either of those flags set.

<58> Section 3.1.5.11.27: This algorithm is only implemented by NTFS. The FAT, EXFAT, CDFS, and UDFS file systems always return 1.

<59> Section 3.1.5.12.5: The following table defines what FileSystemAttributes flags, as defined in [MS-FSCC] section 2.5.1, are set by various Windows file systems and why they are set:

|  | NTFS | FAT | EXFAT | UDFS | CDFS |
|---|---|---|---|---|---|
| FILE_SUPPORTS_USN_JOURNAL 0x02000000 | Set if 3.0 format or higher volume |  |  |  |  |
| FILE_SUPPORTS_OPEN_BY_FILE_ID 0x01000000 | Always Set |  |  | Set if volume mounted read-only | Always Set |
| FILE_SUPPORTS_EXTENDED_ATTRIBUTES 0x00800000 | Always Set |  |  |  |  |

| | NTFS | FAT | EXFAT | UDFS | CDFS |
|---|---|---|---|---|---|
| FILE_SUPPORTS_HARD_LINKS<br>0x00400000 | Always Set | | | Always Set | |
| FILE_SUPPORTS_TRANSACTIONS<br>0x00200000 | Set if 3.0 format or higher volume | | | | |
| FILE_SEQUENTIAL_WRITE_ONCE<br>0x00100000 | | | | Set if volume not mounted read-only | |
| FILE_READ_ONLY_VOLUME<br>0x00080000 | Set if volume mounted read-only | Set if volume mounted read-only | Set if volume mounted read-only | Set if volume mounted read-only | Always Set |
| FILE_NAMED_STREAMS<br>0x00040000 | Always Set | | | Set if 2.0 format or higher | |
| FILE_SUPPORTS_ENCRYPTION<br>0x00020000 | Set if 3.0 format or higher volume and encryption is enabled on the system | | | | |
| FILE_SUPPORTS_OBJECT_IDS<br>0x00010000 | Set if 3.0 format or higher volume | | | | |
| FILE_VOLUME_IS_COMPRESSED<br>0x00008000 | | | | | |
| FILE_SUPPORTS_REMOTE_STORAGE<br>0x00000100 | | | | | |
| FILE_SUPPORTS_REPARSE_POINTS<br>0x00000080 | Set if 3.0 format or higher volume | | | | |
| FILE_SUPPORTS_SPARSE_FILES<br>0x00000040 | Set if 3.0 format or higher volume | | | | |
| FILE_VOLUME_QUOTAS | Set if 3.0 format or | | | | |

| | NTFS | FAT | EXFAT | UDFS | CDFS |
|---|---|---|---|---|---|
| 0x00000020 | higher volume | | | | |
| FILE_FILE_COMPRESSION 0x00000010 | Set if volume cluster size is 4K or less | | | | |
| FILE_PERSISTENT_ACLS 0x00000008 | Always Set | | | | |
| FILE_UNICODE_ON_DISK 0x00000004 | Always Set | Always Set | Always Set | Always Set | Set if Joliet Format |
| FILE_CASE_PRESERVED_NAMES 0x00000002 | Always Set | Always Set | Always Set | Always Set | |
| FILE_CASE_SENSITIVE_SEARCH 0x00000001 | Always Set | | | Always Set | Always Set |

<60> Section 3.1.5.12.5: The following table defines the MaximumComponentNameLength, as defined in [MS-FSCC] section 2.5.1, that is set by each file system:

| | NTFS | FAT | EXFAT | UDFS | CDFS |
|---|---|---|---|---|---|
| MaximumComponentNameLength Value | 255 | 255 | 255 | 254 | 110 if Joliet Format 221 otherwise |

<61> Section 3.1.5.14.1: The following table describes the maximum file size supported by various Windows File Systems:

| | NTFS | FAT | EXFAT | UDFS | CDFS |
|---|---|---|---|---|---|
| MaximumFileSize | 16 TB The physical format will support 16 exabytes | 4 GB | 16 exabytes | 8 TB | 8 TB |

<62> Section 3.1.5.14.4: The following table describes the maximum file size supported by various Windows File Systems:

| | NTFS | FAT | EXFAT | UDFS | CDFS |
|---|---|---|---|---|---|
| MaximumFileSize | 16 TB The physical format will support 16 exabytes | 4 GB | 16 exabytes | 8 TB | 8 TB |

<63> Section 3.1.5.14.9: If **Open.Mode** contains neither FILE_SYNCHRONOUS_IO_ALERT nor FILE_SYNCHRONOUS_IO_NONALERT, this operation does not have any meaningful effect, because **Open.CurrentByteOffset** is not used for any **Open** that does not have either of those flags set.

<64> Section 3.1.5.14.11: The file system only updates LastChangeTime if no user has explicitly set LastChangeTime. Some Windows file systems defer setting the LastChangeTime until the handle is closed.

<65> Section 3.1.5.14.14: ValidDataLength is an internal implementation detail of the NTFS file system. It is not a notion that exists in other Windows file systems. ValidDataLength, as defined by NTFS, refers to a high-watermark in the file that is considered to be initialized data by a user writing in the region or by the file system writing zeros. Any reads within that value are required to return data from the persistent store. Any reads beyond that value are required to return zeros. There is no API to query ValidDataLength, and the API to set ValidDataLength only allows the value to increase from the existing value.

<66> Section 3.1.5.16: The file system only updates LastChangeTime if no user has explicitly set LastChangeTime. Some Windows file systems defer setting the LastChangeTime until the handle is closed.

<67> Section 3.1.5.19: In Windows file systems, operations are only cancelable if they are blocked and put on a wait queue of some kind. Operations that are actively being processed are not cancelable.

<68> Section 3.1.5.20: The name of the quota file in the Windows environment is:

\$Extend\$Quota:$Q:$INDEX_ALLOCATION

<69> Section 3.1.5.21: The name of the quota file in the Windows environment is:

\$Extend\$Quota:$Q:$INDEX_ALLOCATION

# 7   Change Tracking

No table of changes is available. The document is either new or has had no changes since its last release.

# 8 Index