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INTERNATIONAL STANDARD



Information technology – Storage management –
Part 5: Filesystems





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INFORMATION TECHNOLOGY – STORAGE MANAGEMENT – Part 5: Filesystems

FOREWORD

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International Standard ISO/IEC 24775-5 was prepared by subcommittee 25: Interconnection of information technology equipment, of ISO/IEC joint technical committee 1: Information technology.

This International Standard, together with ISO/IEC 24775-1 to ISO/IEC 24775-4 and ISO/IEC 24775-6 to ISO/IEC 24775-8, replaces ISO/IEC 24775, second edition, published in 2011, and constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition.

The list of all currently available parts of the ISO/IEC 24775 series, under the general title *Information technology – Storage management*, can be found on the IEC web site.

This International Standard has been approved by vote of the member bodies, and the voting results may be obtained from the address given on the second title page.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

IMPORTANT – The “colour inside” logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this publication using a colour printer.

Introduction

The Filesystems part of ISO/IEC 24775 contains profiles and other clauses for management of devices and programs that support filesystems. A filesystem is a specific formatting of storage for storing and accessing files on external storage. This part describes how filesystems are created, modified and deleted, as well as how they can be found and reported. This part also describe modeling for how filesystems are exported for access from remote systems. The filesystem profiles use information from other parts of ISO/IEC 24775. Specifically, they reference profiles in the Common Profiles and the Block Devices parts of the standard. This part describes how these profiles are used in filesystem profiles.

Parts of this Standard

This International Standard is subdivided into the following parts:

- *Information technology – Storage management – Part 1: Overview*
- *Information technology – Storage management – Part 2: Common architecture*
- *Information technology – Storage management – Part 3: Common profiles*
- *Information technology – Storage management – Part 4: Block devices*
- *Information technology – Storage management – Part 5: Filesystems*
- *Information technology – Storage management – Part 6: Fabric*
- *Information technology – Storage management – Part 7: Host elements*
- *Information technology – Storage management – Part 8: Media libraries*

Changes since the Last Edition

This third edition cancels and replaces the second edition published in 2011 and constitutes a technical revision. This edition includes the following significant changes with respect to the previous edition. The changes fall into three broad categories:

- **Improved organization.** The International Standard has been reorganized into eight parts to provide more information more easily. The parts are:
 - *Part 1 Overview:* The overview book provides a high level overview of the standard.
 - *Part 2 Common Architecture:* This part covers general information about the interface, such as security and protocols.
 - *Part 3 Common Profiles:* This part covers component profiles that extend profiles in other books, such as target ports and job control.
 - *Part 4 Block Devices:* This part covers storage profiles that support various forms of disk storage.
 - *Part 5 Filesystems:* This part covers profiles that support filesystems, such as NAS (Network Attached Storage).
 - *Part 6 Fabric:* This part covers profiles that deal with interconnection of host servers and storage devices, such as switches.
 - *Part 7 Host Elements:* This part covers profiles for storage software on host servers, such as disk partitioning and Host Hardware RAID controllers.
 - *Part 8 Media Libraries:* This part covers profiles that deal with removable media such as tape libraries.
- **Maturity identification.** As material is added to the standard it goes through various stages of maturity. The initial stage is *Experimental*, which is material that has not yet been implemented and is subject to change. The other stages indicate the degree of implementations. The stages are:
 - **Experimental:** Full design review, no commercial implementations.
 - **Implemented:** Initial implementations available, may be removed at minor revision.

- **Stable:** Three or more vendors have implemented the identified material, backward compatibility assured, removed only at major revision.
- **Finalized:** Relies solely on Finalized content, deprecated only at major revision.
- **Deprecated:** Obsolete material, may be removed in future revisions.
For a more detailed explanation of each maturity level and its typographical indication, see Clause 4 Typographical Conventions.
- **Expanded scope.** The range of SAN components modeled by the profiles defined in the parts has been greatly expanded.
 - New profiles include:
 - *Part 3 Common Profiles:* Serial Attached SCSI (SAS) Target Port, Serial ATA (SATA) Target Ports, SB Target Port, SAS Initiator Ports, ATA Initiator Ports, FC-SB-x Initiator Ports, FCoE Initiator Ports, Power Supply, Fan, Sensors, Base Server, Media Access Device, Storage Enclosure, Software Inventory, Profile Registration, Proxy Server System Management, Operational Power.
 - *Part 4 Block Devices:* Block Storage Views, CKD Block Services, Erasure, Storage Server Asymmetry, Volume Composition, Storage Element Protection, Replication Services, Pools from Volumes, Group Masking and Mapping, Thin Provisioning.
 - *Part 5 Filesystems:* File Export, File Server Manipulation, File Storage, Filesystem, Filesystem Copy Services, Filesystem Performance, Filesystem Quotas, NAS Network Port, Host Filesystem, Filesystem Remote Copy Services.
 - *Part 6 Fabric:* Fibre Channel Security, Fabric Views, Virtual Fabrics, Switch Partitioning, SAS Expander, N Port Virtualizer, Inter Fabric Routing.
 - *Part 7 Host Elements:* Storage HBA, Host Hardware RAID Controller.
 - *Part 8 Media Libraries:* Partitioned Tape Library, Virtual Tape Library, Virtual Tape Library Copy and Library Views.
 - The following experimental profiles were removed from the International Standard:
 - *Part 3 Common Profiles:* Security, 3rd Party Authentication, Authorization, Credential Management, Identity Management, Security Role Based Access Control and Security Resource Ownership.
 - *Part 4 Block Devices:* Pool Management Policy.
 - The following profiles were deprecated:
 - *Part 3 Common Profiles:* Cascading (replaced by direct use of cascading classes).
 - *Part 4 Block Devices:* Volume Management (and not replaced).
 - *Part 6 Fabric:* Router (and not replaced).
 - *Part 7 Host Elements:* FC HBA (replaced by Storage HBA), SB Multipath Management (and not replaced).
 - *Part 8 Media Libraries:* InterLibraryPort Connection (and not replaced).
 - In addition, many of the existing profiles have been enhanced.

This International Standard was prepared by the SNIA (Storage Networking Industry Association)¹. The standard is often referred to as **SMI-S** (*Storage Management Initiative Specification*).

1. Storage Networking Industry Association, 425 Market Street, Suite 1020, San Francisco, CA 94105, U.S.A.
<http://www.snia.org>

INFORMATION TECHNOLOGY – STORAGE MANAGEMENT – Part 5: Filesystems

1 Scope

This part of ISO/IEC 24775 defines management profiles for Autonomous (top level) profiles for programs and devices whose central function is providing support and access to file data. In addition, it provides documentation of component profiles (or subprofiles) that deal with filesystems and management interface functions that may be used by other autonomous profiles not included in this part of the standard.

There is an informative annex that describes how storage is mapped from block storage to file shares exported by the filesystem and the mechanisms involved in establishing those mappings. This annex is recommended for getting an overview of how the filesystem models work.

This part of ISO/IEC 24775 includes two autonomous profiles:

- The NAS Head Profile

This profile defines the model and functions of a NAS device that exports file shares to remote users and gets its storage from a SAN (array devices attached to the NAS Head device).

- The Self-Contained NAS Profile

This profile defines the model and functions of a NAS device that exports file shares to remote users, but gets its storage from disk drives that are internal to the NAS device (instead of externally attached arrays).

In addition to these autonomous profiles, this standard defines a number of component profiles, which are used by the autonomous NAS profiles and might also be used by other autonomous profiles that feature filesystem elements and services. The component profiles (subprofiles) defined in this version of the standard include:

- The File Export (component) Profile

This component profile defines the elements used to model the exporting of filesystems or directories for any autonomous profile that exports file data to remote systems.

- The File Export Manipulation (component) Profile

This component profile defines the elements used to model the services for creating, modifying and deleting the file shares (the representation of exported filesystems or directories) for any autonomous profile that provides manipulation of exported filesystems or directories.

- The File Storage (component) Profile

This component profile defines the elements used to model the storage of filesystems on logical disks. This profile does not have services for maintaining the mapping of filesystems to logical disks. These services are addressed in the Filesystem Manipulation Profile.

- The Filesystem (component) Profile

This component profile defines the elements used to model filesystems and its related elements, such as logical files, directories and information on how the filesystem is addressed when mounted to a specific system. The services for defining and maintaining the information in the Filesystem Profile are contained in the Filesystem Manipulation Profile.

- The Filesystem Manipulation (component) Profile

This component profile defines the elements used to model the services for creating, modifying and deleting filesystems and their related elements.

- The Filesystem Quotas (component) Profile

This component profile defines the elements used to model the elements associated with creating, maintaining and reporting on quotas on various filesystem elements.

2 Normative references

The following documents, in whole or in part, are normatively referenced in the document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document, including any amendments, applies.

ISO/IEC 24775-2:2014, *Information technology – Storage management – Part 2: Common architecture*

ISO/IEC 24775-3:2014, *Information technology – Storage management – Part 3 Common profiles*

ISO/IEC 24775-4:2014, *Information technology – Storage management – Part 4 Block devices*

3 Terms definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in *Information technology – Storage management – Part 2 Common architecture* and the following apply.

3.1.1

Directory

subtree within a filesystem

Note 1 to entry: A directory may contain files or other directories.

3.1.2

File

logical file in a filesystem

3.1.3

File Server

system configuration which supports the exporting of files and files' systems

Note 1 to entry: A file server may be a virtual system element.

3.1.4

File Share

sharing protocols applied to a directory

Note 1 to entry: A directory is exported to remote users through a file share.

3.1.5

Filesystem

way in which files are named and where they are placed logically for storage and retrieval

3.1.6

FS Quota

quota (hard or soft limit) placed on filesystem resource usage

3.1.7

Logical Disk

block storage on which filesystems are built

Note 1 to entry: A logical disk would be formatted for a particular filesystem.

3.1.8

NAS Head

NAS device that gets its physical storage from one or more arrays that are externally attached to the NAS device

3.1.9

Self-Contained NAS

NAS device that has its own internal (to the NAS device) storage

3.1.10

Quota

hard or soft limit defined for users, user groups or resource collections on the amount of resources that may be consumed.

3.2 Abbreviations

CIFS Common Internet File System

NAS Network Attached Storage

NOTE In the context of this standard, this refers to devices that serve files to a network.

NFS Network File System

4 Typographical conventions

4.1 Maturity model

In addition to informative and normative content, this International Standard includes guidance about the maturity of emerging material that has completed a rigorous design review but has limited implementation in commercial products. This material is clearly delineated as described in Clause 4. The typographical convention is intended to provide a sense of the maturity of the affected material, without altering its normative content. By recognizing the relative maturity of different sections of the International Standard, an implementer should be able to make more informed decisions about the adoption and deployment of different portions of the International Standard in a commercial product.

This International Standard has been structured to convey both the formal requirements and assumptions of the Information Technology – Storage Management API and its emerging implementation and deployment lifecycle. Over time, the intent is that all content in the International Standard will represent a mature and stable design, be verified by extensive implementation experience, assure consistent support for backward compatibility, and rely solely on content material that has reached a similar level of maturity. Unless explicitly labeled with one of the subordinate maturity levels defined for this International Standard, content is assumed to satisfy these requirements and is referred to as “Finalized”. Since much of the evolving International Standard content in any given release will not have matured to that level, this International Standard defines three subordinate levels of implementation maturity that identify important aspects of the content’s increasing maturity and stability. Each subordinate maturity level is defined by its level of implementation experience, its stability and its reliance on other emerging standards. Each subordinate maturity level is identified by a unique typographical tagging convention that clearly distinguishes content at one maturity model from content at another level.

4.2 Experimental maturity level

No material is included in this International Standard unless its initial architecture has been completed and reviewed. Some content included in this International Standard has complete and reviewed design, but lacks implementation experience and the maturity gained through implementation experience. This content is included in order to gain wider review and to gain implementation experience. This material is referred to as “Experimental”. It is presented here as an aid to implementers who are interested in likely future developments within the SMI International Standards. The contents of an Experimental profile may change as implementation experience is gained. There is a high likelihood that the changed content will be included in an upcoming revision of the International Standard. Experimental material can advance to a higher maturity level as soon as implementations are available. Figure 1 is a sample of the typographical convention for Experimental content.

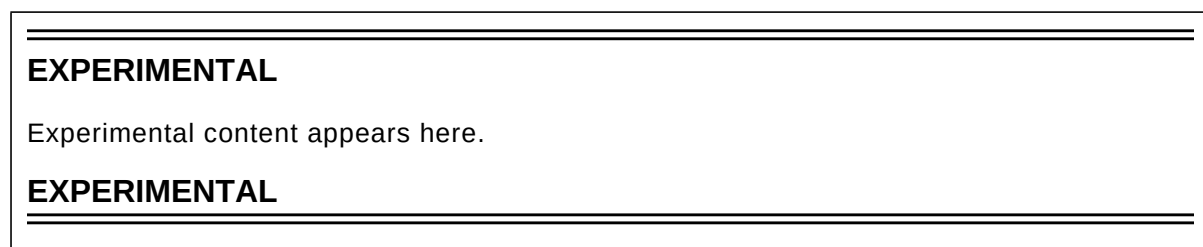


Figure 1 - Experimental maturity level tag

4.3 Implemented maturity level

Profiles for which initial implementations have been completed are classified as “Implemented”. This indicates that at least two different vendors have implemented the profile, including at least one provider implementation. At this maturity level, the underlying architecture and modeling are stable, and changes in future revisions will be limited to the correction of deficiencies identified through additional implementation experience. Should the material become obsolete in the future, it shall be deprecated in a minor revision of the

International Standard prior to its removal from subsequent releases. Figure 2 is a sample of the typographical convention for Implemented content.

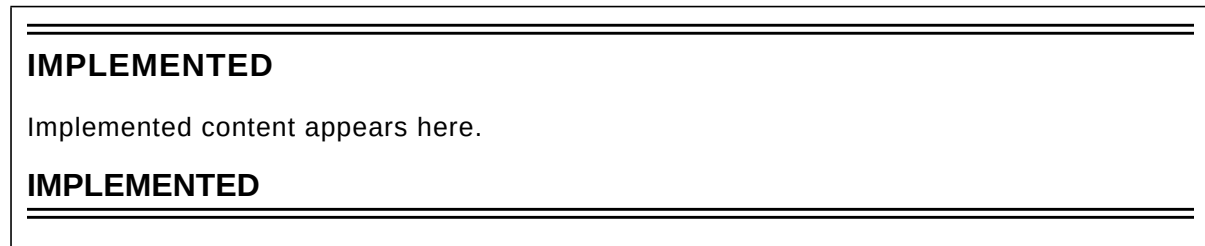


Figure 2 - Implemented maturity level tag

4.4 Stable maturity level

Once content at the Implemented maturity level has garnered additional implementation experience, it can be tagged at the Stable maturity level. Material at this maturity level has been implemented by three different vendors, including both a provider and a client. Should material that has reached this maturity level become obsolete, it may only be deprecated as part of a minor revision to the International Standard. Material at this maturity level that has been deprecated may only be removed from the International Standard as part of a major revision. A profile that has reached this maturity level is guaranteed to preserve backward compatibility from one minor International Standard revision to the next. As a result, Profiles at or above the Stable maturity level shall not rely on any content that is Experimental. Figure 3 is a sample of the typographical convention for Implemented content.

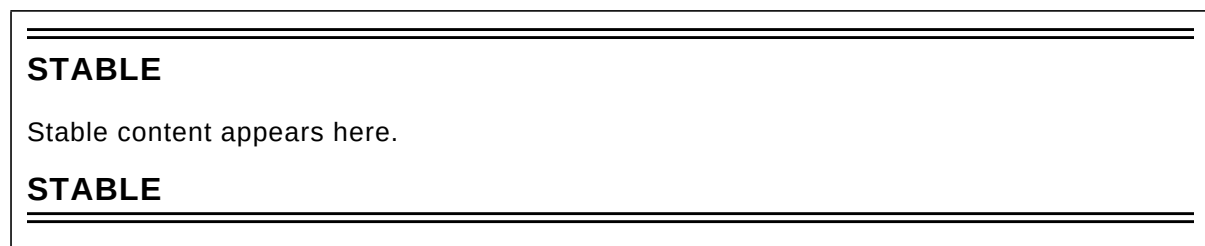


Figure 3 - Stable maturity level tag

4.5 Finalized maturity level

Content that has reached the highest maturity level is referred to as “Finalized.” In addition to satisfying the requirements for the Stable maturity level, content at the Finalized maturity level shall solely depend upon or refine material that has also reached the Finalized level. If International Standard content depends upon material that is not under the control of the SNIA, and therefore not subject to its maturity level definitions, then the external content is evaluated by the SNIA to assure that it has achieved a comparable level of completion, stability, and implementation experience. Should material that has reached this maturity level become obsolete, it may only be deprecated as part of a major revision to the International Standard. A profile that has reached this maturity level is guaranteed to preserve backward compatibility from one minor International Standard revision to the next. Over time, it is hoped that all International Standard content will attain this maturity level. Accordingly, there is no special typographical convention, as there is with the other, subordinate maturity levels. Unless content in the International Standard is marked with one of the typographical conventions defined for the subordinate maturity levels, it should be assumed to have reached the Finalized maturity level.

4.6 Deprecated material

Non-Experimental material can be deprecated in a subsequent revision of the International Standard. Sections identified as “Deprecated” contain material that is obsolete and not recommended for use in new development efforts. Existing and new implementations may still use this material, but shall move to the newer approach as soon as possible. The material is

of the material being deprecated determines how long it will continue to appear in the International Standard. Implemented content shall be retained at least until the next revision of the specialization, while Stable and Finalized material shall be retained until the next major revision of the International Standard. Providers shall implement the deprecated elements as long as it appears in the International Standard in order to achieve backward compatibility. Clients may rely on deprecated elements, but are encouraged to use non-deprecated alternatives when possible.

Deprecated sections are documented with a reference to the last published version to include the deprecated section as normative material and to the section in the current International Standard with the replacement. Figure 4 contains a sample of the typographical convention for deprecated content.



Figure 4 - Deprecated tag

STABLE

5 File Export Profile

5.1 Description

5.1.1 Synopsis

Profile Name: File Export (Component Profile)

Version: 1.4.0

Organization: SNIA

CIM Schema Version: 2.18

Table 1 describes the related profiles for File Export.

Table 1 - Related Profiles for File Export

Profile Name	Organization	Version	Requirement	Description
Indication	SNIA	1.5.0	Mandatory	
Experimental Indication	SNIA	1.5.0	Optional	

Central Class: CIM_FileShare

Scoping Class: CIM_ComputerSystem

5.1.2 Overview

The File Export Profile is a subprofile for autonomous profiles that support exporting of filesystems. Specifically, in this release of SMI-S, this includes the NAS Head and Self-Contained NAS Profiles. In some of these autonomous profiles the File Export is required. In others it may not be. See the parent profile to see if this profile is required or not.

EXPERIMENTAL

The ExportedFileShareSetting is defined as SNIA_classes. While this is defined to hold new properties, the CIM version of this class will be supported for backward compatibility.

EXPERIMENTAL

5.1.3 Implementation

5.1.3.1 General

Figure 5 illustrates the classes mandatory for modeling the export of File Shares for the filesystem profiles. This profile is supported by the Self-contained NAS and the NAS Head Profiles. Figure 5 shows the ComputerSystem that hosts the LocalFilesystem ("filesystem host") as different from the ComputerSystem hosting the FileShare ("File server"). While they may be different ComputerSystems, they may also be the same ComputerSystem instance.

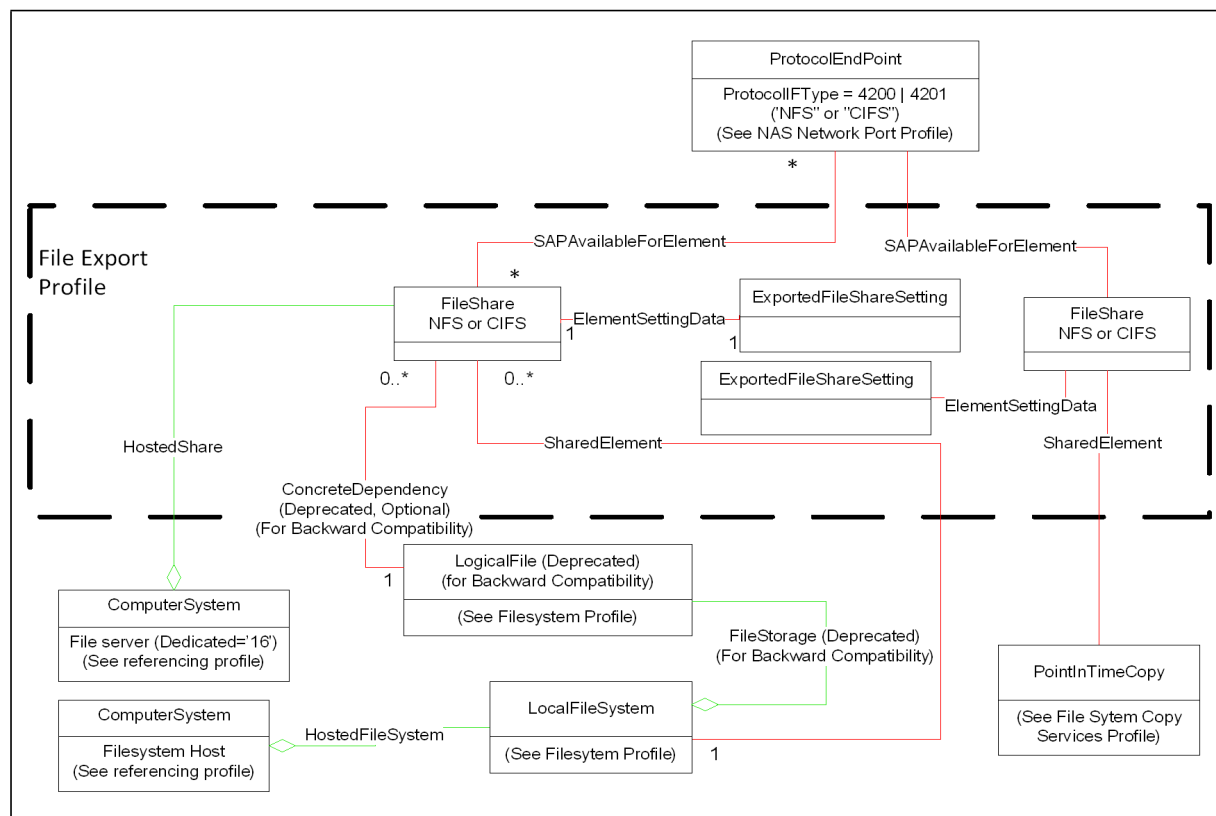


Figure 5 - File Export Instance

The referencing profile shall model any File Shares that have been exported to the network. A File Share shall be represented as a FileShare instance with associations to the ComputerSystem that hosts the share (via HostedShare), to the ExportedFileShareSetting (via ElementSettingData) and to the ProtocolEndpoint (via SAPAvailableForElement) through which the Share can be accessed.

EXPERIMENTAL

The FileShare also has a SharedElement association to the LocalFileSystem on which the share is based.

Note that a FileShare may be defined on a PointInTimeCopy (of a filesystem). A FileShare may refer to either a LocalFileSystem or a PointInTimeCopy of a filesystem. But a FileShare cannot reference both a LocalFileSystem and a PointInTimeCopy.

EXPERIMENTAL

DEPRECATED

In addition, there may also be an association between the FileShare and the LogicalFile that the share represents (via ConcreteDependency). This is provided for backward compatibility with previous releases of the standard.

DEPRECATED

5.1.3.2 Associations to FileShare

The SAPAvailableForElement is a many to many association. That is, multiple FileShares may be exported through the same ProtocolEndpoint and multiple ProtocolEndpoints may support the same FileShare.

The SharedElement association between the FileShare and a LocalFileSystem is many to one association. Zero or more FileShares may be associated to one LocalFileSystem. But each FileShare shall only reference one LocalFileSystem.

DEPRECATED

The ConcreteDependency association between the FileShare and the LogicalFile is a many to one association. Zero or more FileShares may be associated to one LogicalFile. But each FileShare shall only reference one LogicalFile.

DEPRECATED

The ElementSettingData association between the FileShare and the ExportedFileShareSetting is a one to one association. That is, a FileShare shall have an ExportedFileShareSetting and that ExportedFileShareSetting shall be associated to exactly one FileShare.

5.2 Health and Fault Management Consideration

5.2.1 General

The File Export Profile supports state information (e.g., OperationalStatus) on the following element of the model:

- FileShares that are exported (see 5.2.2).

5.2.2 OperationalStatus for FileShares

Table 2 shows FileShare operationalStatus.

Table 2 - FileShare OperationalStatus

OperationalStatus	Description
OK	FileShare is online.
Error	FileShare has a failure. This could be due to a filesystem failure.
Stopped	FileShare is disabled.
Unknown	

5.3 Cascading Considerations

None.

5.4 Supported Profiles, Subprofiles, and Packages

See 5.1.1 for information.

5.5 Methods of the Profile

5.5.1 Extrinsic Methods of the Profile

None.

5.5.2 Intrinsic Methods of the Profile

The profile supports read methods and association traversal. Specifically, the list of intrinsic operations supported are as follows:

- GetInstance
- Associators
- AssociatorNames
- References
- ReferenceNames
- EnumerateInstances
- EnumerateInstanceNames

5.6 Client Considerations and Recipes

To list existing FileShares on the system, a client shall be able to find FileShares attached to a system (e.g., a file server) by doing an association traversal from the ComputerSystem that represents the system using the HostedShare association.

5.7 CIM Elements

5.7.1 General

Table 3 describes the CIM elements for File Export.

Table 3 - CIM Elements for File Export

Element Name	Requirement	Description
5.7.2 CIM_ConcreteDependency	Optional	Deprecated. Represents an association between a FileShare element and the actual shared LogicalFile or Directory on which it is based. This is provided for backward compatibility.
5.7.3 CIM_ElementSettingData (FileShare)	Mandatory	Associates a FileShare and ExportedFileShareSetting elements.
5.7.4 CIM_ExportedFileShareSetting (Setting)	Mandatory	The configuration settings for an Exported FileShare that is a setting for a FileShare available for exporting.
5.7.5 CIM_FileShare (Exported File Share)	Mandatory	Represents the sharing characteristics of a particular file element.
5.7.6 CIM_HostedShare	Mandatory	Represents that a shared element is hosted by a File Server Computer System.
5.7.7 CIM_SAPAvailableForElement	Mandatory	Represents the association between a ProtocolEndpoint to the shared element that is being accessed through that SAP.
5.7.8 CIM_SharedElement	Mandatory	Associates a FileShare to the LocalFileSystem on which it is based.
SELECT * FROM CIM_InstModification WHERE SourceInstance ISA CIM_FileShare AND SourceInstance.OperationalStatus <> PreviousInstance.OperationalStatus	Mandatory	Deprecated WQL - Change of Status of a FileShare. PreviousInstance is optional, but may be supplied by an implementation of the Profile.
SELECT * FROM CIM_InstModification WHERE SourceInstance ISA CIM_FileShare AND SourceInstance.CIM_FileShare::OperationalStatus <> PreviousInstance.CIM_FileShare::OperationalStatus	Optional	CQL - Change of Status of a FileShare. PreviousInstance is optional, but may be supplied by an implementation of the Profile.

5.7.2 CIM_ConcreteDependency

Deprecated.

Created By: External

Modified By: Static

Deleted By: External

Requirement: Optional.

Table 4 describes class CIM_ConcreteDependency.

Table 4 - SMI Referenced Properties/Methods for CIM_ConcreteDependency

Properties	Requirement	Description and Notes
Antecedent	Mandatory	The LogicalFile that is being shared.
Dependent	Mandatory	The Share that represents the LogicalFile being shared.

5.7.3 CIM_ElementSettingData (FileShare)

Created By: External

Modified By: Static

Deleted By: External

Requirement: Mandatory.

Table 5 describes class CIM_ElementSettingData (FileShare).

Table 5 - SMI Referenced Properties/Methods for CIM_ElementSettingData (FileShare)

Properties	Requirement	Description and Notes
IsDefault	Optional	Not Specified in this version of the Profile.
IsCurrent	Optional	Not Specified in this version of the Profile.
IsNext	Optional	Not Specified in this version of the Profile.
IsMinimum	Optional	Not Specified in this version of the Profile.
IsMaximum	Optional	Not Specified in this version of the Profile.
ManagedElement	Mandatory	The FileShare.
SettingData	Mandatory	The settings define on creation of the FileShare.

5.7.4 CIM_ExportedFileShareSetting (Setting)

Created By: External

Modified By: External

Deleted By: External

Requirement: Mandatory.

Table 6 describes class CIM_ExportedFileShareSetting (Setting).

Table 6 - SMI Referenced Properties/Methods for CIM_ExportedFileShareSetting (Setting)

Properties	Requirement	Description and Notes
InstanceID	Mandatory	A unique ID for the setting.
ElementName	Mandatory	A user-friendly name for the Setting.
FileSharingProtocol	Mandatory	The file sharing protocol supported by this share. NFS (2) and CIFS (3) are the supported values.
ProtocolVersions	Mandatory	An array of the versions of the supported file sharing protocol. A share may support multiple versions of the same protocol.
InitialEnabledState	Optional	Valid values are '1 2 3 7 8 9' for ('Other' 'Enabled' 'Disabled' 'In Test' 'Deferred' 'Quiesce').
OtherEnabledState	Optional	This should be filled in if the InitialEnabledState is '1'.
DefaultUserIdSupported	Optional	Valid values are '2 3 4' for ('No Default User Id' 'System-Specified Default User Id' 'Share-Specified Default User Id').
RootAccess	Optional	Valid values are '2 3' for ('No Root Access' 'Allow Root Access').
AccessPoints	Optional	Valid values are '2 3 4 5' for ('None' 'Service Default' 'All' 'Named Points').
Caption	Optional	Not Specified in this version of the Profile.
Description	Optional	Not Specified in this version of the Profile.
DefaultReadWrite	Optional	Not Specified in this version of the Profile.
DefaultExecute	Optional	Not Specified in this version of the Profile.
ExecuteSupport	Optional	Not Specified in this version of the Profile.
WritePolicy	Optional	Not Specified in this version of the Profile.

5.7.5 CIM_FileShare (Exported File Share)

Created By: External

Modified By: External

Deleted By: External

Requirement: Mandatory.

Table 7 describes class CIM_FileShare (Exported File Share).

Table 7 - SMI Referenced Properties/Methods for CIM_FileShare (Exported File Share)

Properties	Requirement	Description and Notes
InstanceID	Mandatory	A unique id for the FileShare element.
ElementName	Mandatory	This shall be a user friendly name for the FileShare.
Name	Mandatory	This shall be an opaque string that uniquely identifies the path to the directory or file.

Table 7 - SMI Referenced Properties/Methods for CIM_FileShare (Exported File Share)

Properties	Requirement	Description and Notes
SharingDirectory	Mandatory	Indicates if the shared element is a file or a directory. This is useful when importing but less so when exporting.
OperationalStatus	Mandatory	The OperationalStatus of the FileShare as defined in 4.2.1.
Description	Optional	This is a comment describing the file share.
Caption	Optional	Not Specified in this version of the Profile.
InstallDate	Optional	Not Specified in this version of the Profile.
StatusDescriptions	Optional	Not Specified in this version of the Profile.
HealthState	Optional	Not Specified in this version of the Profile.
EnabledState	Optional	Not Specified in this version of the Profile.
OtherEnabledState	Optional	Not Specified in this version of the Profile.
RequestedState	Optional	Not Specified in this version of the Profile.
EnabledDefault	Optional	Not Specified in this version of the Profile.
TimeOfLastStateChange	Optional	Not Specified in this version of the Profile.
RequestStateChange()	Optional	Not Specified in this version of the Profile.

5.7.6 CIM_HostedShare

Created By: External

Modified By: External

Deleted By: External

Requirement: Mandatory.

Table 8 describes class CIM_HostedShare.

Table 8 - SMI Referenced Properties/Methods for CIM_HostedShare

Properties	Requirement	Description and Notes
RemoteShareWWN	Optional	Not Specified in this version of the Profile.
Dependent	Mandatory	The Share that is hosted by a Computer System.
Antecedent	Mandatory	The Computer System that hosts the FileShare. This can be the top level or non-top level system, or a virtual file server. But it shall be a File Server (Dedicated='16').

5.7.7 CIM_SAPAvailableForElement

Created By: External

Modified By: Static

Deleted By: External

Requirement: Mandatory.

Table 9 describes class CIM_SAPAvailableForElement.

Table 9 - SMI Referenced Properties/Methods for CIM_SAPAvailableForElement

Properties	Requirement	Description and Notes
ManagedElement	Mandatory	The element that is made available through a SAP. In the File Export subprofile, these are FileShares configured for either export.
AvailableSAP	Mandatory	The Service Access Point that is available to this FileShare. This shall have a value of '4200' (NFS) or '4201' (CIFS).

5.7.8 CIM_SharedElement

Created By: External

Modified By: Static

Deleted By: External

Requirement: Mandatory.

Table 10 describes class CIM_SharedElement.

Table 10 - SMI Referenced Properties/Methods for CIM_SharedElement

Properties	Requirement	Description and Notes
SystemElement	Mandatory	The LocalFileSystem that is exporting some contained file or directory as a FileShare.
SameElement	Mandatory	The FileShare that exposes a contained file or directory of the LocalFileSystem as an exported object.

STABLE

EXPERIMENTAL

6 File Export Manipulation Subprofile

6.1 Description

6.1.1 Synopsis

Profile Name: File Export Manipulation (Component Profile)

Version: 1.4.0

Organization: SNIA

CIM Schema Version: 2.18

Table 11 describes the related profiles for File Export Manipulation.

Table 11 - Related Profiles for File Export Manipulation

Profile Name	Organization	Version	Requirement	Description
Job Control	SNIA	1.5.0	Optional	
File Export	SNIA	1.4.0	Mandatory	
Indication	SNIA	1.5.0	Mandatory	
Experimental Indication	SNIA	1.5.0	Optional	

Central Class: FileExportService

Scoping Class: File server ComputerSystem element (with Dedicated property containing "16")

6.1.2 Overview

The File Export Manipulation Subprofile is a subprofile of autonomous profiles that support filesystems. It makes use of elements of the filesystem subprofiles and supports creation, modification and deletion of FileShares that are exported by the File Export Subprofile. A number of other profiles and subprofiles also make use of elements of the filesystem subprofile and will be referred to in this standard as "filesystem related profiles" – these include but are not limited to the filesystem subprofile, the Filesystem Manipulation Subprofile, the File Export Subprofile, the NAS Head Profile, the Self-Contained NAS Profile, and so on.

In this standard, the autonomous profiles that use the File Export Manipulation Subprofile are the NAS Head and Self-Contained NAS Profiles.

Annex B, "(informative) State Transitions from Storage to File Shares" describes the states that a storage element, initially an unused LogicalDisk, goes through before it can be exported as a CIFS or NFS file share. The Filesystem Manipulation Subprofile provides the methods to create the filesystem as a LocalFileSystem and make it locally accessible at a file server ComputerSystem (associated to the file server ComputerSystem via the LocalAccessAvailable association). This profile (the File Export Manipulation Profile) provides the methods to "Export a file share" from the file server that allows the file server to share its contents with remote operational users. Sharing the contents of a LocalFileSystem can be from the root directory or some contained internal directory, or some contained internal file. When a directory (root or otherwise) is shared, all files and sub-directories of that directory are also automatically shared (recursively). The semantics of sharing are ultimately controlled by the Authorization profiles and by the filesystem implementation, so sharing cannot violate the access rules specified internally to the filesystem. In addition to specifying the object (file or directory) to be shared, the filesystem implementation shall specify the protocol to use (CIFS, NFS, or other protocol) for sharing.

SMI-S uses a FileShare element to represent the externally accessible file share. A SharedElement association will exist between the FileShare and the LocalFileSystem. The FileShare.Name property indicates the shared object (it is the filesystem-specific path to the contained file or directory that is being shared). The format of Name is specific to the filesystem type indicated by the associated FileSystemSetting.ActualFileSystemType property. The LocalFileSystem.PathNameSeparatorString property indicates the "separator string" that may be used to split the PathName into the components of a hierarchical path name from the root of the associated filesystem (indicated by the LocalFileSystem).

6.1.3 Instance Diagrams

6.1.3.1 File Export Creation classes and associations

Figure 6 illustrates the constructs involved with creating a FileShare for a File Export Subprofile. This summarizes the mandatory classes and associations for this subprofile. Specific areas are discussed in later clauses.

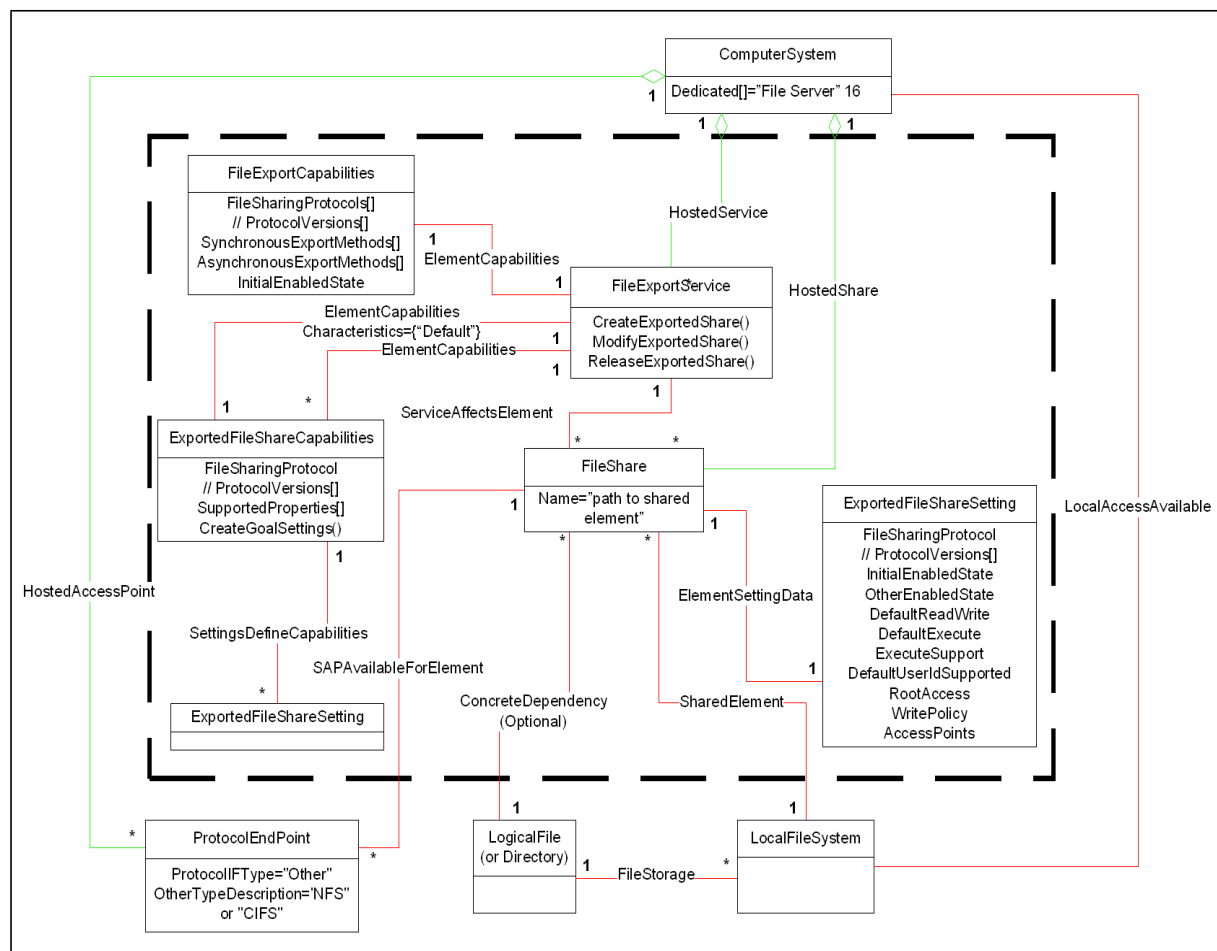


Figure 6 - File Export Manipulation Subprofile Instance

The FileExportService provides configuration support for exporting elements ('files' and 'directories') of a LocalFileSystem as FileShare elements. A FileExportService is hosted by the file server ComputerSystem that exports the directories/files (these would be the file server ComputerSystems in the filesystem subprofile that were given local access to the filesystem). FileShares are accessed through ServiceAccessPoint(s) hosted by the file server ComputerSystem. FileShares are associated with the FileExportService via ServiceAffectsElement and with the ServiceAccessPoint(s) via SAPAvailableToElement.

If a filesystem-related profile supports the File Export Manipulation Subprofile, it shall have at least one FileExportService element. This FileExportService shall be hosted on the top level ComputerSystem of the File Export Subprofile (which shall be a file server ComputerSystem).

element in the filesystem related profiles). The methods offered are CreateFileShare, ModifyFileShare, and ReleaseFileShare.

Associated to the FileExportService (via ElementCapabilities) shall be one FileExportCapabilities element that describes the capabilities of the service. It identifies the methods supported, whether the methods support Job Control or not, the protocols that the created file share can support, and whether or not the file share shall be made available after creation.

For each file sharing protocol that is supported, there shall be one ExportedFileShareCapabilities element that defines the range of capabilities supported for that particular file sharing protocol. The ExportedFileShareCapabilities elements shall be associated via ElementCapabilities to the FileExportService. One of the ExportedFileShareCapabilities may be identified as a default (by setting the property ElementCapabilities.IsDefault). The default ExportedFileShareCapabilities element also indicates the default file sharing protocol to be supported. These defaults apply if any of the extrinsic methods of the FileExportService are invoked with a NULL value for the Capabilities parameter.

Each ExportedFileShareCapabilities element is defined by a set of ExportedFileShareSettings that are associated to it by the SettingsDefineCapabilities association. These ExportedFileShareSettings may be structured to indicate a range of supported and unsupported property values and shall have the same value for the FileSharingProtocol property as the ExportedFileShareCapabilities element.

For the convenience of clients the File Export Manipulation Subprofile may populate a set of "pre-defined" ExportedFileShareSettings for each of the ExportedFileShareCapabilities. These shall be associated to the ExportedFileShareCapabilities via the SettingsDefineCapabilities association – the association shall have its SettingsDefineCapabilities.PropertyPolicy property set to "Correlated" and the SettingsDefineCapabilities.ValueRole property set to "Supported". That they are pre-defined and therefore exist at all times does not imply that these ExportedFileShareSettings shall be made persistent by the implementation.

The ExportedFileShareCapabilities instance supports the CreateGoalSettings method, described in detail in , "Table 14 shows methods and instances for FileExportManipulation.". This method supports establishing one client-defined ExportedFileShareSettings (as a goal).

CreateGoalSettings takes an array of embedded SettingData elements as the input TemplateGoalSettings and SupportedGoalSettings parameters and may generate an array of embedded SettingData elements as the output SupportedGoalSettings parameter. However, this profile only uses a single embedded ExportedFileShareSettings element in the input parameters (both TemplateGoalSettings and SupportedGoalSettings) and generate a single valid embedded ExportedFileShareSettings element as output (SupportedGoalSettings). If a client supplies a NULL ExportedFileShareSettings (i.e., the empty string) as input to this method, the returned ExportedFileShareSettings structure shall be a default setting for the parent ExportedFileShareCapabilities. If the input (the embedded ExportedFileShareSettings) is not NULL, the method may return a "best fit" to the requested setting. The client may iterate on the CreateGoalSettings method until it acquires a setting that suits its needs. This embedded settings structure may then be used when the CreateFileShare or ModifyFileShare methods are invoked. The details of how iterative negotiation can work are discussed in 6.5.1.2, "ExportedFileShareCapabilities.CreateGoalSettings". Note that the file sharing protocol indicated by the FileSharingProtocol property is invariant in all of these interactions. It is an error if the client changes the FileSharingProtocol property for a Setting and submits it as a goal to the Capabilities element that provided the original Setting.

Note that it is not possible to guarantee that negotiation will terminate with an agreed upon setting and therefore a fall-back mechanism is needed. This profile does not require negotiation – an implementation may support only a set of pre-defined correlated point settings that a client can preload and use without modification. The implementation could also support the only settings whose properties are selectable from an arithmetic progression or from a

fixed enumeration, so that the client may construct a goal setting that is guaranteed to be supported without negotiation.

Note that if a client has obtained a goal setting supported by the implementation this does not guarantee that a create or modify request will succeed. Such a setting only specifies a supported static configuration not that the current dynamic environment has the resources to implement a specific request.

Armed with the goal (the embedded `ExportedFileShareSettings` element), a reference to a `LocalFileSystem`, and a path to a file or directory contained within that `LocalFileSystem`, the client can now use the `CreateFileShare` method to create the file share for export. The `CreateFileShare` method creates a `FileShare` element, and a new `ExportedFileShareSettings` instance as well as several necessary associations. These associations are:

- `HostedFileShare` association between the `FileShare` and the file server `ComputerSystem` that hosts it.
- `SharedElement` association between the `FileShare` and the `LocalFileSystem`. In addition, the `FileShare` element specifies the pathname for the shared element (file or directory) relative to the root of the `LocalFileSystem` (using the `Name` property).
- `ElementSettingData` to associate the `FileShare` to the `ExportedFileShareSetting` defined for it.
- For backward compatibility with previous releases of SMI-S:
 - The file or directory of the `LocalFileSystem` that is being shared is represented as a `LogicalFile`.
 - A `FileStorage` association is created between the `LogicalFile` and the `LocalFileSystem`.
 - A `ConcreteDependency` association is created between the `FileShare` and the `LogicalFile`.
- In addition, optional parameters to the method can cause other classes to be created:
 - `DefaultUserId` could create a `Privilege` (see Clause 6 File Export Manipulation Subprofile) associated to the `FileShare` as `AuthorizationTarget` and to a `UserIdentity` as `AuthorizationSource`.
 - `RootAccessHosts` array parameter could create root access `Privileges` from a number of remote Host `ComputerSystems` to the `FileShare` (also using the Security Authorization Subprofile).
 - `AccessPointPorts` array parameter could create `SAPAvailableForElement` associations to a number of `ProtocolEndPoints` representing TCP/IP ports through which access is provided to this `FileShare`.

The `ReleaseFileShare` method is straightforward – it deletes the `FileShare` and the `ExportedFileShareSetting`, and the associations to those elements (`HostedFileShare`, the `ElementSettingData` element, `SharedElement`, all the `SAPAvailableForElement` associations and all `Privileges` that reference this `FileShare` as an `AuthorizationTarget`). Any `ComputerSystem` elements created to represent remote hosts with root access to this `FileShare` that have no further references may also be removed. A `LogicalFile` element associated to the `LocalFileSystem` via `FileStorage` will not necessarily be deleted (the implementation may keep track of the other users of this element and be able to delete it). For similar reasons, a `ProtocolEndPoint` created as a result of being specified in the `AccessPointPorts` parameter may not be deleted. In both these cases, if the element has no associations other than the scoping one (`FileStorage` to `LocalFileSystem` for `LogicalFile` and `HostedAccessPoint` to `ComputerSystem` for `ProtocolEndPoint`) the provider may stop surfacing it at any time.

The `ModifyFileShare` method modifies an existing `FileShare` – this requires a new `ExportedFileShareSetting` element to be used as a goal. But not any `ExportedFileShareSetting` will do. The client shall use the `ExportedFileShareCapabilities.CreateGoalSettings` method which would have been used to create the file share, or an appropriate compatible `ExportedFileShareCapabilities` instance. The `CreateGoalSettings` method is used to establish a new `ExportedFileShareSetting` goal (as with the original file share creation, it may be necessary to iterate on the `CreateGoalSettings` method). Since only properties controlled by

6.1.3.2 Finding File Export Services, Capabilities and Pre-defined Settings



If no service is found from the Top Level file server ComputerSystem, the client should look for other component file server ComputerSystems that may be hosting the service. This is not recommended, but permitted.

For each entry in the FileSharingProtocol array, there shall be one instance of ExportedFileShareCapabilities with the same value for the FileSharingProtocol property that shall be associated to the FileExportService using the ElementCapabilities association (filtering on the result value of "CIM ExportedFileShareCapabilities"). This

ExportedFileShareCapabilities element shall specify the supported capabilities for that FileSharingProtocol using a collection of ExportedFileShareSetting elements. These ExportedFileShareSettings shall be associated the ExportedFileShareCapabilities via SettingsDefineCapabilities.

An implementation may support a set of pre-defined ExportedFileShareSettings that clients could use directly if desired. The SettingsDefineCapabilities association from the ExportedFileShareCapabilities to the pre-defined ExportedFileShareSettings shall have the PropertyPolicy property be "Correlated", the ValueRole property be "Supported" and the ValueRange property be "Point". Other pre-defined combinations of property values may be specified by ExportedFileShareSettings whose SettingsDefineCapabilities association has the PropertyPolicy be "Independent", ValueRole property be "Supported" and the ValueRange array property contain "Minimums", "Maximums", or "Increment". These settings can be used by the client to compose ExportedFileShareSetting instances that are more likely to be directly usable.

6.2 Health and Fault Management Considerations

6.2.1 General

The key elements of this profile are the FileExportService and the file server ComputerSystem.

6.2.2 OperationalStatus for FileExportService

Table 12 shows the operational status for FileExport services.

Table 12 - Operational Status for FileExport Service

Primary OperationalStatus	Description
2 "OK"	The service is running with good status.
3 "Degraded"	The service is operating in a degraded mode. This could be due to the health state of the underlying file server, or of the storage being degraded or in error.
4 "Stressed"	The services resources are stressed.
5 "Predictive Failure"	The service might fail because some resource or component is predicted to fail.
6 "Error"	An error has occurred causing the service to become unavailable. Operator intervention through SMI-S to restore the service may be possible.
6 "Error"	An error has occurred causing the service to become unavailable. Automated recovery may be in progress.
7 "Non-recoverable Error"	The service is not functioning. Operator intervention through SMI-S will not fix the problem.
8 "Starting"	The service is in process of initialization and is not yet available operationally.
9 "Stopping"	The service is in process of stopping, and is not available operationally.
10 "Stopped"	The service cannot be accessed operationally because it is stopped – if this did not happen because of operator intervention or happened in real-time, the OperationalStatus would have been "Lost Communication" rather than "Stopped".
11 "In Service"	The service is offline in maintenance mode, and is not available operationally.
13 "Lost Communications"	The service cannot be accessed operationally – if this happened because of operator intervention it would have been "Stopped" rather than "Lost Communication".
14 "Aborted"	The service is stopped but in a manner that may have left it in an inconsistent state.
15 "Dormant"	The service is offline, and the reason for not being accessible is unknown.

Table 12 - Operational Status for FileExport Service

Primary OperationalStatus	Description
16 "Supporting Entity in Error"	The service is in an error state, or may be OK but not accessible, because a supporting entity is not accessible.

6.2.3 OperationalStatus for File Server ComputerSystem

Table 13 shows operational status for File Server ComputerSystem.

Table 13 - Operational Status for File Server ComputerSystem

Primary OperationalStatus	Description
2 "OK"	The file server is running with good status.
3 "Degraded"	The file server is operating in a degraded mode. This could be due to the health state of some component of the ComputerSystem, due to load by other applications, or due to the health state of backend or front-end network interfaces.
4 "Stressed"	The file server resources are stressed.
5 "Predictive Failure"	The file server might fail because some resource or component is predicted to fail.
6 "Error"	An error has occurred causing the ComputerSystem to become unavailable. Operator intervention through SMI-S to restore the service may be possible.
6 "Error"	An error has occurred causing the ComputerSystem to become unavailable. Automated recovery may be in progress.
7 "Non-recoverable Error"	The file server ComputerSystem is not functioning. Operator intervention through SMI-S will not fix the problem.
8 "Starting"	The ComputerSystem is in process of initialization and is not yet available operationally.
9 "Stopping"	The ComputerSystem is in process of stopping, and is not available operationally.
10 "Stopped"	The ComputerSystem cannot be accessed operationally because it is stopped – if this did not happen because of operator intervention or happen in real-time, the OperationalStatus would have been "Lost Communication" rather than "Stopped".
11 "In Service"	The ComputerSystem is offline in maintenance mode, and is not available operationally.
13 "Lost Communications"	The ComputerSystem cannot be accessed operationally – if this happened because of operator intervention it would have been "Stopped" rather than "Lost Communication".
14 "Aborted"	The ComputerSystem is stopped but in a manner that may have left it in an inconsistent state.
15 "Dormant"	The ComputerSystem is offline, and the reason for not being accessible is unknown.
16 "Supporting Entity in Error"	The ComputerSystem is in an error state, or may be OK but not accessible, because a supporting entity is not accessible.

6.3 Cascading Considerations

Not Applicable.

6.4 Supported Subprofiles and Packages

See 6.1.1 for this type of information.

6.5 Methods of the Profile

6.5.1 Extrinsic Methods of the Profile

6.5.1.1 General

Table 14 shows methods and instances for FileExportManipulation.

Table 14 - FileExportManipulation Methods

Method	Created Instances	Deleted Instances	Modified Instances
CreateExportedShare	FileShare (Export) ExportedFileShareSetting ElementSettingData HostedShare SharedElement SAPAvailableForElement ServiceAffectsElement LogicalFile (or Directory) (<i>for bc to 1.1</i>) ProtocolEndPoint	N/A	N/A
ModifyExportedShare			ExportedFileShareSetting FileShare (Export) ProtocolEndPoint
ReleaseExportedShare	N/A	FileShare (Export) ExportedFileShareSetting ElementSettingData HostedShare SharedElement ServiceAffectsElement ProtocolEndPoint LogicalFile	N/A
CreateGoalSettings	N/A	N/A	N/A

6.5.1.2 ExportedFileShareCapabilities.CreateGoalSettings

6.5.1.2.1 General

This extrinsic method of the ExportedFileShareCapabilities class validates support for a caller-proposed ExportedFileShareSetting passed as the TemplateGoalSettings parameter. This profile restricts the usage of this method to a single entry array for both TemplateGoalSettings and SupportedGoalSettings parameters.

If the input TemplateGoalSettings is NULL or the empty string, this method returns a single default ExportedFileShareSetting in the SupportedGoalSettings array. Both TemplateGoalSettings and SupportedGoalSettings are string arrays containing embedded instances of type ExportedFileShareSetting. As such, these settings do not exist in the implementation but are the responsibility of the client.

If the TemplateGoalSettings specifies values that cannot be supported, this method shall return an appropriate error and should return a best match for SupportedGoalSettings.

The client and the implementation can engage in a negotiation process that may require iterative calls to this method. To assist the implementation in tracking the progress of the negotiation, the client may pass previously returned values of SupportedGoalSettings as the new input value of SupportedGoalSettings. The implementation may determine that a step has not resulted in progress if the input and output values of SupportedGoalSettings are the same. A client may infer from the same result that the TemplateGoalSettings shall be modified.

6.5.1.2.2 Client Considerations

It is important to understand that the client is acting as an agent for a human user – either a "system" administrator, or other entity with administrative privileges with respect to the filesystem, the filesystem host, or the file server or the file share. During negotiation, the client will show the current state to the user – the SupportedGoalSettings received to date (either the latest or some subset), the TemplateGoalSettings proposed (the most recent, but possibly more). But the administrator needs a representation of what is available, possibly the range or sets of values that the different setting properties can take. Some decisions are assumed to have been made already, such as the file-sharing protocol to be used or the filesystem element to be shared or the resources allocated for providing local access to the filesystem from the file server.

The SettingsDefineCapabilities association from the selected Capabilities element provides the information for the client to lay out these options. "Point" settings can be identified using ExportedFileShareSettings – these points can be further qualified to indicate whether these are supported (or not), and even whether they represent some ideal point in the space – a "minimum", or a "maximum", or an "optimal" point. Other settings can provide ranges for properties – by specifying a minimum, a maximum, and an increment an arithmetic progression of values can be specified (a continuous range can be specified with a zero increment). Specifying a set of supported values for a property that do not follow some pattern is possible, if a bit tedious.

The set of settings associated via SettingsDefineCapabilities are expected to be quite stable – real systems do not continually vary the functionality they can support. Such variations do occur – for instance, if a new PCMCIA card is added to a running system – and the best way for a client to be able to add these to the set of choices presented to a user is to subscribe to indications on new Capabilities elements and new instances of SettingsDefineCapabilities.

There is no guarantee that a negotiation will terminate successfully with the client and the implementation achieving agreement. The implementation may support some simpler mechanisms, short of fully-fledged negotiation, that would be used by a client to obtain an acceptable TemplateGoalSettings. The following two use cases are easily covered:

- 1) Client only considers the canned settings specified exactly. The canned settings are specified by the ExportedFileShareSetting elements that are associated to the ExportedFileShareCapabilities via SettingDefinesCapabilities association with the following property values:
 - SettingDefinesCapabilities.PropertyPolicy = "Correlated"
 - SettingDefinesCapabilities.ValueRole = "Supported"
 - SettingDefinesCapabilities.ValueRange = "Point"
- 2) Client considers canned settings that range over values specified using minimum/increment/maximum for the Setting properties. For example, these could be specified by the ExportedFileShareSetting elements that are associated to the ExportedFileShareCapabilities via SettingDefinesCapabilities association with the following property values:
 - SettingDefinesCapabilities.ValueRange = "Minimums" or "Maximums" or "Increments"
 - The PropertyPolicy and ValueRole properties of SettingDefinesCapabilities will be appropriately specified.