

Network File System Version 4
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T. Haynes
Hammerspace
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Adding an Uncacheable Directory Attribute to NFSv4.2
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Abstract

The Network File System version 4.2 (NFSv4.2) allows a client to cache both metadata for file and directory objects. While caching directory entries (dirents) can improve performance, it can also prevent the server from enforcing access control on individual dirents. This document introduces a new uncacheable directory attribute for NFSv4.2. Dirents marked as uncacheable MUST NOT be stored in client-side caches. This ensures data consistency and integrity by requiring clients to always retrieve the most recent data directly from the server. This document extends NFSv4.2 (see RFC7862).

Note to Readers

Discussion of this draft takes place on the NFSv4 working group mailing list (nfsv4@ietf.org), which is archived at https://mailarchive.ietf.org/arch/search/?email_list=nfsv4. Source code and issues list for this draft can be found at <https://github.com/ietf-wg-nfsv4/uncacheable-directories>.

Working Group information can be found at <https://github.com/ietf-wg-nfsv4>.

Status of This Memo

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1. Introduction

With a remote filesystem, the client typically caches both directory entries (dirents) in order to improve performance. Several assumptions are made about the rate of change in the dirents. With NFSv4.2, this could theoretically be mitigated by directory delegations for the dirents.

There are prior efforts to bypass the dirent caching. Access Based Enumeration (ABE) is used in Server Message Block (SMB) [SMB2] protocol to effectively limit the namespace visibility per user.

This document introduces the uncacheable directory attribute to NFSv4.2 to implement ABE. As such, it is an OPTIONAL to implement attribute for NFSv4.2. However, if both the client and the server

support this attribute, then the client MUST follow the semantics of uncacheable dirents.

// What about mixed modes?

A client can easily determine whether or not a server supports the uncacheable directory attribute with a simple GETATTR on any dirent. If the server does not support the uncacheable attribute, it will return an error of NFS4ERR_ATTRNOTSUPP.

The only way that the server can determine that the client supports the attribute is if the client sends either a GETATTR or a SETATTR with the uncacheable directory attribute.

Using the process detailed in [RFC8178], the revisions in this document become an extension of NFSv4.2 [RFC7862]. They are built on top of the external data representation (XDR) [RFC4506] generated from [RFC7863].

1.1. Definitions

Access Based Enumeration (ABE) When servicing a REaddir or GETATTR operation, the server provides results based on the access permissions of the user making the request.

dirent A directory entry, representing either a file or a subdirectory. In the context of NFSv4, a dirent marked as uncacheable MUST NOT be cached by clients.

dirent caching A client cache that is used to avoid looking up attributes.

file caching A client cache, normally called the page cache, which caches the contents of a regular file. Typical usage would be to accumulate changes to be bunched together for writing to the server.

Further, the definitions of the following terms are referenced as follows:

- * directory delegations (Section 10.9 of [RFC8881])
- * GETATTR (Section 18.7 of [RFC8881])
- * hidden (Section 5.8.2.15 of [RFC8881])
- * Mandatory Access Control (MAC) ([RFC4949])
- * NF4DIR (Section 5.8.1.2 of [RFC8881])

- * NFS4ERR_ATTRNOTSUPP (Section 15.1.15.1 of [RFC8881])
- * mode (Section 6.2.4 of [RFC8881])
- * offline (Section 2 of [RFC9754])
- * owner (Section 5.8.2.26 of [RFC8881])
- * owner_group (Section 5.8.2.27 of [RFC8881])
- * READDIR (Section 18.23 of [RFC8881])
- * SETATTR (Section 18.30 of [RFC8881])
- * system (Section 5.8.2.36 of [RFC8881])
- * type (Section 5.8.1.2 of [RFC8881])

1.2. Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

2. Caching of Dirents

With a remote filesystem, the client typically caches directory entries (dirents) locally to improve performance. This cooperation succeeds because both the server and client operate under POSIX semantics ([POSIX.1]) and agree to interpretation of mode bits with respect to the uid and gid in NFSv3 [RFC1813]. For NFSv4.2, these would respectively be the mode, owner, and owner_group attributes defined in Section 5 of [RFC8881]. Note that this cooperation does not apply to Access Control List (ACLs) entries as NFSv4.2 does not implement a strict POSIX style ACL.

NFSv4.2 does implement NFSv4.1 ACLs, which are enforced on the server and not the client. As such, ACL enforcement requires the client to bypass the dirent cache to have checks done when a new user attempts to access the dirent.

Another consideration is that not all server implementations natively support the SMB [SMB2]. Instead, they layer Samba [Samba] on top of the NFSv4.2 service. The attributes of hidden, system, and offline have already been introduced in the NFSv4.2 protocol to support Samba. The Samba implementation can utilize these attributes to provide SMB semantics. While private protocols can supply these features, it is better to drive them into open standards.

Another concept that can be adapted from SMB is that of Access Based Enumeration (ABE). If a share or a folder has ABE enabled, then the user can only see the files and sub-folders for which they have permissions.

Under the POSIX model, this can be done on the client and not the server. However, that only works with uid, gid, and mode bits. If we consider identity mappings, ACLS, and server local policies, then the determination of ABE MUST be done on the server.

Since cached dirents are shared by all users on a client, and the client cannot determine access permissions for individual dirents, all users are presented with the same set of attributes. To address this, this document introduces the new uncacheable directory attribute. This attribute instructs the client not to cache the dirent for a file or directory object. Consequently, each time a client queries for these attributes, the server's response can be tailored to the specific user making the request.

2.1. Uncacheable Dirents

If a file object or directory has the uncacheable directory attribute set, then the client MUST NOT cache its dirent attributes. This means that even if the client has previously retrieved the attributes for a user, it MUST query the server again for those attributes on subsequent requests. Additionally, the client MUST NOT share attributes between different users.

3. XDR for Offline Attribute

```
///  
/// typedef bool                fattr4_uncacheable_directory;  
///  
/// const FATTR4_UNCACHEABLE_DIRECTORY    = 88;  
///
```

4. Extraction of XDR

This document contains the external data representation (XDR) [RFC4506] description of the uncacheable directory attribute. The XDR description is presented in a manner that facilitates easy extraction into a ready-to-compile format. To extract the machine-readable XDR description, use the following shell script:

```
#!/bin/sh
grep '^ *///' $* | sed 's?^ */// ??' | sed 's?^ *///$??'
```

For example, if the script is named 'extract.sh' and this document is named 'spec.txt', execute the following command:

```
sh extract.sh < spec.txt > uncacheable_prot.x
```

This script removes leading blank spaces and the sentinel sequence '///' from each line. XDR descriptions with the sentinel sequence are embedded throughout the document.

Note that the XDR code contained in this document depends on types from the NFSv4.2 nfs4_prot.x file (generated from [RFC7863]). This includes both nfs types that end with a 4, such as offset4, length4, etc., as well as more generic types such as uint32_t and uint64_t.

While the XDR can be appended to that from [RFC7863], the code snippets should be placed in their appropriate sections within the existing XDR.

5. Security Considerations

For a given user A, a client MUST NOT make access decisions for uncacheable dirents retrieved for another user B. These decisions MUST be made by the server. If the client is Labeled NFS aware ([RFC7204]), then the client MUST locally enforce the MAC security policies.

The uncacheable directory attribute allows dirents to be annotated such that attributes are presented to the user based on the server's access control decisions.

6. IANA Considerations

This document has no IANA actions.

7. References

7.1. Normative References

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Author's Address

Thomas Haynes
Hammerspace
Email: loghyr@gmail.com