FluidFS SMB Sparse Files

Explanation and Demo

Dell Compellent FS8600 Network-Attached Storage (NAS)

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# Revisions

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1 Preface

1.1 Audience
This document is intended on the one hand for designers, software engineers and programmers who design systems that work on NAS files, and on the other hand for systems, networking, or storage administrators who handle management responsibilities of a Dell FS8600 FluidFS NAS solution.

Proper management of an FS8600 requires administrators (or teams of administrators) who can:

- Manage and configure enterprise-class Fibre Channel SAN and Ethernet networks
- Use any necessary enterprise-grade backup software
- Use the Dell Compellent Storage Center
- Perform general purpose NAS administration

1.2 Purpose
One purpose of this document is to help the storage administrator understand the storage requirements of NAS volumes when using SMB sparse files.

Another purpose is to help software engineers use the SMB sparse files features in their software.

1.3 Disclaimer
The information contained within this document is intended to provide best practices and general recommendations only. Actual configurations in customer environments may need to vary due to individual circumstances, budget constraints, service level agreements, applicable industry-specific regulations, or other factors. Configurations should be tested before implementing them in a production environment.

1.4 Customer Support
Dell Compellent provides live support at 1-866-EZSTORE (866.397.8673), 24 hours a day, 7 days a week, 365 days a year. For additional support, email Dell Compellent at support@compellent.com. Dell Compellent responds to emails during standard business hours (US Central Time).
2 Introduction

FluidFS is an enterprise-class distributed file system that allows customers to easily and efficiently manage file data. FluidFS removes the scaling limitations of traditional file systems. It also supports scale-out performance and scale-up capacity expansion, all within a single namespace for easier administration. Because FluidFS optimizes performance and scalability, it is an excellent choice for a wide range of use cases and deployment environments.

2.1 Sparse files

A sparse file is a file with one or more regions of unallocated data on it (which are treated as zeros). Large files that are mostly zeros can be efficiently represented by sparse files. An extreme example is a file that has a single non-zero byte after 100GB of zeros.

Here is a graphic of a sparse file (source: https://en.wikipedia.org/wiki/Sparse_file)

2.2 Sparse files and FluidFS

FluidFS has always handled sparse files internally for NFS.

From version 5 of FluidFS v5, SMB sparse files are also supported. This includes support for the actions described below. We don’t know of any off-the-shelf applications that use SMB sparse files, but home-grown applications can use them for appropriate cases and save disk storage space.
2.3 Sparse file operations

Configuration (powershell)

**Set sparse:** fsutil sparse setflag <filePath> 1/0 (turn on/off)

**Verify sparse:** fsutil sparse queryflag <filePath>

**Set ranges of zeros:** fsutil sparse setrange <filePath> <offset> <length>

**Verify ranges:** fsutil sparse queryrange <filePath>
SMB Sparse Files Demo

The following demo was prepared by Peter Long, EMEA Product Technologist at Dell.

The FluidFS system is based on the firmware release: 5.0.002821

The Compellent system is based on the firmware release: 7.0.1.306

The laptop used to run the command line and the FSUTIL tool is based on the release: windows 8.1 Ent.
3.1 Platform state at the beginning

We have a NAS volume named “PL_nas02” of 10 GB which contains an SMB share named “pl_share02”. We have 10 GB of capacity and consume 4 GB of data.

The share is mounted as an SMB share on a Windows laptop as a network drive (letter: ‘P’). We have created (copied) a file, ‘myfile’, of 4 GB of data (non-zero data):

As the goal is to demonstrate that the reclaim mechanism works from the file system/share to the Compellent storage array (CML pages), here are the details about the 4 volumes containing the NAS data.
From the laptop, we can see by using the command line or the windows properties on the share 'pl_share02' the same informations:

- Myfile size : 4 GB
- Used space on the share : 4.02 GB
- Free space on the share : 5.97 GB
- Total capacity of the share : 10 GB
3.2 Actions performed during the demo

All commands below are based on the utility: `fsutil.exe` embedded in the Windows operating system.

From the laptop and by using the command line window, we can check if the share (aka ‘volume’ for Windows) supports the sparse files:

```
PS P:/> fsutil fsinfo volumeinfo P:
Volume Name : PL_nas02
Volume Serial Number : 0x6eb10
Max Component Length : 255
File System Name : NTFS
Is ReadWrite
Preserves Case of filenames
Supports Unicode in filenames
Preserves & Enforces ACL’s
Supports Sparse files
Supports Reparse Points
Supports Named Streams
PS P:/>
```

Result: this share supports the sparse files.

We are going to check if the file ‘myfile’ is a sparse file or be considered as a sparse file. The file system must know how to interpret the data inside the file and there is a flag dedicated to the sparse file:

```
PS P:/> fsutil sparse queryflag P:\myfile
This file is NOT set as sparse
PS P:/>
```

Result: the file is not yet considered as a sparse file

The first thing to do is to enable the sparse flag for this file. To perform this action, we are going to use the fsutil tool and the `FSCTL_SET_SPARSE` primitive:

```
PS P:/> fsutil sparse setflag P:\myfile
PS P:/> fsutil sparse queryflag P:\myfile
This file is set as sparse
PS P:/>
```
Result: the first command enables the sparse flag and the result is checked just after by using the queryflag command. The file ‘myfile’ is now set as a sparse file. The file system can interpret a range of ‘zeros’ as not really needed and deallocate the corresponding part (no disk allocation).

The second primitive we can use is the FSCTL_QUERY_ALLOCATED_RANGES which returns the part of a file containing NON-zero data.

```
PS P:/> fsutil sparse queryrange P:\myfile
Allocated range[1]: Offset: 0x0   Length: 0x10024b800
PS P:
```

Result: the result is showing that all data inside the file ‘myfile’ are NON zero data => from the beginning (offset = 0x0) to the length : 0x10024b800 (which represents 4 GB), so to the end of the file.

The last primitive we can use is the FSCTL_SET_ZERO_DATA which can write ‘zeros’ in a part of a file. In this example below, I decided to use:

- the offset = 0x40000000 (which represents 1 GB)
- the length = 0x80000000 (which represents 2 GB)

So, in the file ‘myfile’ based on his size of 4 GB, I am writing ‘zero’ as data from 1 GB for a portion of 2 GB.

```
PS P:/> fsutil sparse setrange P:\myfile 0x40000000 0x80000000
PS P:/> fsutil sparse queryrange P:\myfile
Allocated range[1]: Offset: 0x0   Length: 0x40000000
Allocated range[2]: Offset: 0xc0000000 Length: 0x4024b800
PS P:
```

Result: we have divided the file in two parts containing real data (NON zero data) and in the middle we have a portion of 2 GB of ‘zero’ data. This can be checked by using the queryrange command which returns the two parts containing real data:

- from 0x0 to length : 0x40000000 (which represents from 0 GB to 1 GB)
- from 0xc0000000 to length : 0x4024b800 (which represents from 3 GB to 4 GB)
3.3 FluidFS reclaiming

The process is automatic and take several seconds which is conditioned by the FluidFS activity and the job to do. Now, we can see that the NAS volume status is showing a space used of 2 GB compared to 4 GB at the beginning.

![Image of NAS Volume Status]

The share mounted on windows is showing the same file 'myfile' with a size of 4 GB (no change of course).

![Image of Share with File]

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FluidFS SMB Sparse Files
The share properties is showing a used space of 2 GB in accordance with the NAS volume information returned by the FluidFS system (see the Storage Manager Client).

So, the file system has deallocated the portion of ‘zero’ data on the fly.

For each read operation you will perform on the file ‘myfile’, the file system will return the number of ‘zero’ needed but it doesn’t store them anymore.

So, you save capacity in this case.

Last thing to check is the reclaiming process for the back-end storage.

Compared to the beginning, the space allocated by the nasdemo volume is reduced in accordance with the space saved with ‘zero’ data (aka sparse file).

3.4 Notes

- We have used the fsutil MS-Windows command-line utility to perform the required operations. Normally these operations will be done with an application using the appropriate SMB verbs.
• SMB sparse files are supported from version 5.0 of FluidFS, which was released in January 2016. Previous versions of FluidFS already supported NFS sparse files.

3.5 Conclusion

The sparse file capability is supported by the FluidFS system which reclaims also the space on the back-end storage by combining it with the unmap feature.

Keep in mind that during all the demo and actions performed, there was no snapshot taken which could ‘keep’ the space unreclaimed until its expiration.
Additional Resources

The FluidFS section at DellTechCenter contains additional technical content such as white papers, best practices, product demos and more:

http://en.community.dell.com/techcenter/storage/w/wiki/6935.dell-fluidfs-nas