XFS File System and File Recovery Tools

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Abstract

XFS file system is a designed to suppot very large system and parallelism efficiently. This is feature attracks different organizations which handle big data. Even there consumers electronic devices which use XFS file systems. But there are very few file explorer and recover tools that can work on XFS file system. In this paper we discuss major features of XFS file system and two file explore and recovey tools.

Keywords: XFS file system, file explorer, file recovery

1. Introduction

File system as one of main component of operating system, it has been evolved to cope with advancement of storage devices capacity and parallel processing. For in-stance ext file system went through much evolution ext2, ext3, ext4 .Some of the reason for these advancement were need to support large file system, large file and short recovery period after crash.

Around 1990s, it became clear that EFS (Extent File System) that would not be efficient to support the new application which require high disk capacity, bandwidth capacity and parallelism. As response to these challenges, SGI developed XFS file system from scratch [1]. XFS was ported to Linux in 1999 and today is used by well-known institution such CERN and Fermilab managing petabytes of storage for scientific. Kernel.org also uses XFS to serve many projects [2].

2. XFS Features

2.1 Allocations Groups

XFS file system is partitioned regions called allocation groups (AGs).The main purposes of these partitions are to avoid need of structures which are 64 bit, scalability and parallelism .but XFS supports full bit file systems. Every global counter in the system is 64 bits in length. AGs limit the size of XFS data structure in range of where they can work efficiently and manageable size. Because of structure AGs, it is possible to free space management and inode allocation can be done in parallel. Therefore, processes running concurrently can allocate space in the file system concurrently [6].

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2.2 Fast Crash Recovery

The XFS has recovery mechanism which is based on journaling .The XFS file system can recovery within a few seconds after system failure. The recovery time is independent of the file system size but it depends on the level of activity in the file system at time of failure [3].

2.3 Large File System

XFS is a full 64-bit file system .As result address of disk blocks and the inode numbers are 64-bits in length. A single file system can theoretically be as large as 18 million terabytes [5].

2.4 Managing Free Space

Space management is key to good file system performance and scalability. Efficiently allocating and freeing space and keeping the file system from becoming fragmented are essential to good file system performance. XFS has replaced the block oriented bitmaps of other file systems with an extent oriented with structure consisting of a pair of B+ trees for each allocation group [6].

2.5 Supporting Large Files

XFS is a full 64-bit file system. All data structures are appropriately designed to sup-port files as large as 9 million Terabyte file [5].

2.6 Supporting Large Number of Files

XFS supports a huge numbers of files, it also allocates inodes dynamically as need .Additionally XFS file system users are not expected to guess number of files when the file system is created [4].

2.7 Supporting Large Directories

The XFS file system implements hierarchical name space like UNIX but XFS supports large number of files in single a directory.

2.8 Performance Scalability

XFS is designed to provide high performance file and file system access. XFS can handle striped arrays of where the where total bandwidth of the drives gives high performance. The aggregate bandwidth of a disk array can only be achieved if all of the drives in the array are constantly busy [4].Additionally, high performance in XFS file system is achieved by allocating files continuously .XFS allocates files continuously by using the following mechanisms.

Delaying Allocation

It is key feature of XFS file system in allocating files continuously. XFS reserves blocks in the file system for the data buffered in memory. Disk block is allocated only when the buffered data is flushed to disk. This delaying helps the allocator to know the final size of the file before making the decision.

Supporting Large Extents

XFS uses very large extent descriptors in the file extent map. Each descriptor can describe up to two million file system blocks, because it uses 21 bits in the extent descriptor to store the length of the extent [4].

Supporting Variable Block Sizes

XFS allows the file system block size to range from 512 bytes to 64 kilobytes on a per file system basis. The file system block size is the minimum unit of allocation and I/O request size [4].

Avoiding File System Fragmentation:

In XFS file system, fragmentation has minimal effects. Since the combination of delayed allocation and allocation B+ helps the allocator to efficiently allocate best fitting extents in the file system for the allocation.

2.9 Guaranteed Rate I/O

The XFS guarantee rate I/O system (GRIO) is one of the features of XFS .GRIO al-lows applications to reserve specific bandwidth to from the file system. XFS will calculate the performance available and guarantee that the requested level of performance is met for a specified time. This frees the programmer from having to predict the performance, which can be complex and variable on flexible systems [3].

3. Current Status of XFS

3.1 Companies Using XFS

There are many companies that currently using XFS file system .It is possible to find list of companies which use XFS file system on [9]. Next we discuss two implementations of XFS in large scale.

Dell's HPC NFS Storage Solution

The Dell NFS Storage Solution (NSS) is a unique new storage solution providing cost-effective NFS storage as an appliance. Designed to scale from 20 TB installations up to 80 TB of usable space, the NSS is delivered as a fully configured, ready-to-go storage solution and is available with full hardware and software support from Dell. XFS was chosen for the NSS because XFS is capable of scaling beyond 16 TB and provides good performance for a broad range of applications

The DØ Experiment at Fermilab

At the DØ experiment at the Fermi National Accelerator Laboratory they have a ~150 node cluster of desktop machines all using the SGI-patched kernel. Every large disk (>40Gb) or disk array in the cluster uses XFS including 4x640Gb disk servers and several 60-120Gb disks/arrays.

The two important reasons XFS file system is preferred from other file system are supporting very large file system and supporting parallelism efficiently. In general, any company which is involved in handling large data, XFS will be good choice.

3.2 Document

Silicon Graphics started developing XFS in 1993, with first deployment on IRIX 5.3 in 1994. The file system was released under the GNU General Public License in May 2000, and ported to Linux, with the first distribution support appearing in 2001. It later became available in almost all GNU/Linux distributions .XFS was first merged into the mainline Linux kernel in version 2.4 (around 2002), making it almost universally available on Linux systems [6].

It is possible to find XFS community activity on [7] .This website contains varies useful information about the XFS file system. One of the documents that found on the website is XFS file system Structure document [8] which contains XFS file system specification .But this document is incomplete as it is mentioned in the document and additionally it is dated 2006 .Still after six year is not possible to find a document which has complete and up-to-date information about XFS system specification. But it is possible information about changes related to XFS in Linux kernel main stream on [7].

3.3 XFS recovery Tools

There are a few recovers tool which can be used to recover deleted XFS file. Next we discuss two recovery tools.

UFS Explorer Professional Recovery

UFS Explorer Professional Recovery tool is commercial and closed source. As it was mentioned in [11] the tool supports file recovery on the following file systems.
Supported Operating Systems

- Windows 32 bits and 64 bits

- Linux

- Mac OS Xc

PhotoRec *Recovery*

PhotoRec is open source software and is licensed under the terms of the GNU General Public License. It mentioned in [12] the following operating systems are supported by PhotoRec.
Supported Operating systems

- DOS/Windows 9x

- Windows NT 4/2000/XP/2003/Vista/2008/7

- Linux,

- FreeBSD, NetBSD, OpenBSD,

- SunOS and

- MacOS X

3.4 Comparison between UFS Explorer and PhotoRec Recovery Tool

Table 1. Comparison between UFS Explorer and PhotoRec Recovery Tool

	UFS Explorer	PhotoRec
UGI	Yes	No
Consistent Result	Yes	No
Recover small file (<1KB)	No	No
Recover Big file (> 3 GB)	Yes	Partially
Easy to use	Yes	Yes

In general UFS Explorer and recovery tool is easy to use with simple UGI. It works well with may file system such as ext3/ext4, XFS, FAT and NTFS as it was mentioned by the developer .While we were testing its functionality , we observed some problem .For example it was not possible to recover small file using the tool form XFS file system. Videos file (avi) recovered form XFS, we could not play with windows media player. Because it was not recognized by the player. We had to use another video player with built-in repairing capability.

Even though PhotoRec is command based tool, we found it easy to use. As it is mentioned in the above table, PhotoRec could recover big file it was not complete. Additionally for similar testing conditions such file system and file size, the result was inconsistent.

4. Need of New Recovery Tool for XFS File system

Current XSF file system is used mostly at organizational level. But, there is consumer electronics such as Samsung TVs (model UE40C7000W) that uses XFS for recording purpose [10]. As high capacity storage devices get cheaper, there is the possibility of that XFS common used by consumer electronics because of its supporting high capacity storage device and high throughput.

Data recovery tools that support XFS file systems can be useful at organizational and individual level when important data is deleted unintentionally or deliberately. Even though there a few recovery tools that support XFS recovery tools, but it will be disadvantages for users to depend on only few products because of the following reasons.

- a product can discontinue because of many reasons

- a product can be very expensive because of lack competent

- usually a few number of products means limited number of functionality

5. Conclusion

Currently, there are many file systems and additionally big removable storage devices are getting cheaper and cheaper. But we face change when we try to access one file system by different operating systems for example XFS file system on Windows .Moreover, when we lose important data accidentally. We need recover the lost data regardless of the file system .Therefore, it is important to develop file explorer and recovery tools that support different kinds of such as XFS file system.

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