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Comparative study of File systems (NTFS, FAT, FAT32, EXT2, EXT3, EXT4)

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Abstract: Over the years, hard drives and the systems used to store data on them have constantly evolved. There are Windows file systems and Linux file system. And have several advantages and disadvantages.

File systems have traditionally been a major area of research and development. This is evident from the existence of over 50 file systems of varying popularity in the current version of the Linux kernel. Windows 2000 supports several file systems, the most important of which are FAT-16, FAT-32, and NTFS (NT File System).

This paper looks at various file systems (FAT NTFS EXT2 EXT3 EXT4) and performing comparative study.

I. INTRODUCTION

In today's world everything revolves around data. Data is critical for day-to-day operation of any system. Data management is taken care of by file systems which reliably store data on disks. Users typically have varied requirements ranging from scalability, availability, fault-tolerance, performance guarantees in business environment to small memory footprints, security, and reliability in desktop environments. This has driven the file system community to develop a variety of systems that cater to different user requirements. Since they were developed over twenty years ago, the role of personal computers in our lives has drastically increased. To store and used data, produce products, and conduct business.

In computing, a file system controls how data is stored and retrieved. Without the file system we can store the data but it is unorganized data. Data placed in a storage medium would be one large body of data. These types of data can't retrieve properly due to unorganized data.

Ext2, Ext3, Ext4, among the hundreds of Linux local file systems, are the most popular, stable and widely used candidates in Linux servers. All of the four file systems were designed with different principles and provide various formats and mount options. Ext2 divides the disk partition into fix-sized blocks and introduces the concept of block groups each of which consist of a fixed number (equates to the number of bits in a block) of blocks to reduce file fragmentation. Windows Operating System (OS) has played an important role in our life, and NTFS, which stored and managed the important data, is the common file system under Windows Operating System.

NTFS is a highly complex and sophisticated file system. It was designed from scratch, rather than being an attempt to improve the old MS-DOS files system. There are different types file systems. we study the different type of file system. The File system contains some types and they are as given below:-

- 1) FAT32
- 2) FAT
- 3) NTFS
- 4) EXT2, EXT3, EXT4.

II. WINDOWS OS FILE SYSTEMS

MS-DOS and Windows 95/98/NT/2000/XP allow use of FAT-16 or FAT-32. Windows NT/2000/XP uses NTFS (NT File System). Windows 2000 also supports read-only file systems for CD-ROMs and DVDs. It is possible (even common) to have the same running system have access to multiple file system types available at the same time. We study all these type of file system.

A. FAT (File Allocation Table)

The file system is simple types of files systems. It consists of file system descriptor

Sector, file system block allocation table and plain storage space to store files and folders.

FAT originated with MS-DOS in 1977. At the time, DOS was a 16-bit operating system, built around 16-bit computer architecture. In 16-bit OS, each sector of a hard disk drive was assigned a 16-bit number, limiting the number of sectors to 65,535. Hard drive have lager in size, it would have to be partitioned into sections equal to or less than 32MB. FAT directory composed of a long list

and short list together. Always a long list of each group followed their short list of matches with itself, which is for the low version of MS-DOS/Windows system, only the short list is visible, there is no pair of long short list directory completely not visible.

Version of FAT file system

- 1) FAT12- FAT12 is the file system that my 32 MB SD card was formatted with (all SD cards > 4 GB are formatted with FAT32). FAT12 used in different physical formats, but a typical floppy disk at the time was 5.25-inch (130 mm), single-sided, 40 tracks, with 8 sectors per track. The capacity of 160 KB for both the system areas and files
- 2) FAT16- Introduced in 1988, primary file system for MS4.0 up to Windows95 . Support drives size up to 2GB. FAT16 not provide large partition than FAT12. FAT16 used in smaller clusters, making disk usage more efficient, particularly for large numbers of files only a few hundred bytes in size.
- 3) FAT32 – FAT32 is the latest version of the FAT (file-allocation table) file system. FAT32 was developed by Microsoft to accommodate the ever-increasing size of hard disk drives. It was first introduced with Windows 95 OSR2, and later with Windows 98, and Windows 2000. FAT-32 uses 32-bit block number which supports 4GB of block numbers and disks up to 2TB in size.

B. NTFS (New Technology File System)

NTFS stands for *New Technology File System* and this took over from FAT as the primary file system being used in the Windows system. This NTFS file system is secure and supports larger file sizes and hard drives.

NTFS is a common file system under Windows NT OS and Windows NT advanced network server OS. Meanwhile it is a special disk format designed for management safety features, such as web disk quota and file encryption.

In NTFS, system obtains the storage location of data by Master File Table (MFT). MFT is a database relative to the file, consisting of a series of File Record. The MFT is file on which NTFS maps there records. MFT is pre-assigned record associated with disk management, known as metadata file.

NTFS file name have limitation up to 255 characters and full paths are limited to 32,767 characters. File names are in Unicode, it not supported the Latin alphabet which is used in countries (e.g., Greece, Japan, India, Russia, and Israel).

An NTFS file is not a linear sequence of bytes, like FAT-32 and UNIX files. NTFS file consists of multiple attributes, each of which is represented by a stream of bytes.

The goals of NTFS are to provide:

- 1) Reliability, which is especially desirable for high end systems and file servers
- 2) A platform for added functionality
- 3) Support POSIX requirements
- 4) Removal of the limitations of the FAT and HPFS file system.

C. Comparison between FAT, FAT32, NTFS as below

FAT	FAT32	NTFS
Volume from floppy diskette size up to 4 GB	Volumes from 512 MB to 2 terabytes	Volume 10 MB to 2 TB
Maximum file size 2 GB	Maximum file size 4 GB	File size limited by size of volume
Does not support Windows 2000 or Windows Server 2003 Active Directory	Does not support Windows 2000 or Windows Server 2003 Active Directory	Required to use Windows 2000 or Windows Server 2003 Active Directory or shared cluster drives
Allows access to files on the hard disk with PC-DOS.	Allows access to files on the hard disk with PC-DOS.	Does not allow access to files on the hard disk with PC-DOS.
Allows you to customize your server with NWSD configuration files	Allows you to customize your server with NWSD configuration files.	Cannot use NWSD configuration files.
Allows you to use the NWSD dump tool (QFPDMPPLS) to retrieve files from the disk for service	Allows you to use the NWSD dump tool to retrieve files from the disk for service	Cannot use the dump tool to retrieve files from the disk

III. LINUX FILE SYSTEMS

An open source environment like Linux has around 50 different file systems that provide different guarantees, targeting varied media. In an open source environment, file systems are typically developed and maintained by several programmers across the globe. Ext2, Ext3, Ext4, among the hundreds of Linux local file systems, are the most popular, stable and widely used candidates in Linux servers. All of the four file systems were designed with different principles and provide various formats and mount options.

In Linux file system we study the file systems (Ext2, Ext3, and Ext4) as follows:

A. Ext2-

The ext2 or second extended file system is a file system for the Linux kernel. It was initially designed by Remy Card as a replacement for the extended file system (ext). It was the first commercial-grade file system for Linux. Maximum file size can be from 16 GB to 2 TB. Overall ext2 file system size can be from 2 TB to 32 TB.

B. Ext3

Ext3 the third extended file system is the commonly used filesystem on Linux. It is extension of ext2. Ext3 is introduced in 2001 which is Developed by Stephen Tweedie. Starting from Linux Kernel 2.4.15 ext3 was available. Maximum file size can be from 16GB to 2TB. Over all ext3 file system size can be from 2TB to 32TB. There are three types of journaling available in ext3 file system.

C. Ext4

Ext4 was born as a series of backward-compatible extensions to ext3, many of them originally developed by Cluster File Systems for the Lustre file system between 2003 and 2006, meant to extend storage limits and add other performance improvements. It support the maximum file size as comparative to others file system. The maximum file size can be from 16 GB to 16 TB. Some new features are describe in Ext4 as: It support multiblock allocation, delayed allocation, journal checksum. All you need to know is that these new features have improved the performance and reliability of the file system when compared to ext3.

1) Comparison Between Ext2, Ext3, Ext4 as Below

Ext2	Ext3	Ext4
Ext2 stands for second extended file system.	Ext3 stands for third extended file system.	Ext4 stands for fourth extended file system.
It was introduced in 1993. Developed by Rémy Card.	It was introduced in 2001. Developed by Stephen Tweedie.	It was introduced in 2008.
This was developed to overcome the limitation of the original ext file system.	Starting from Linux Kernel 2.4.15 ext3 was available.	Starting from Linux Kernel 2.6.19 ext4 was available.
Ext2 does not have journaling feature.	The main benefit of ext3 is that it allows journaling.	Supports huge individual file size and overall file system size.
Maximum individual file size can be from 16 GB to 2 TB	Maximum individual file size can be from 16 GB to 2 TB	Maximum individual file size can be from 16 GB to 16 TB
Overall ext2 file system size can be from 2 TB to 32 TB	Overall ext3 file system size can be from 2 TB to 32 TB	Overall maximum ext4 file system size is 1 EB (exabyte). 1 EB = 1024 PB (petabyte). 1 PB = 1024 TB (terabyte).

IV. CONCLUSION

In this paper we study the Windows file system which contain the FAT, FAT12, NTFS file system and Linux file system contain Ext2, Ext3, Ext4 file system. We also study there advantages and disadvantage. We comparative study this type of file system.



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