Analysis based on Linux file system performance

Zhi Li, Zhili Shen, Yixuan Lu, Bolin Chen, Zhaoxing Lyu, Zhaoyu Han

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*Abstract*—an Operating System consists of many parts, including security system, I/O device, file system was one of those . It is responsible for storing files and managing them, which does have many responsibilities. However, the speed of doing these depends on performance of the file system, but the performance depends on the parts of it : category structure, set of files. Linux, with EXT as its file system , has weakness in dealing with a large amount of files. Due to the limitation of hardware and poor skill in coding, this report would give only theoretical analysis on category structure of file system. Otherwise, other famous file systems will be used to analyze such that comparisons could be made among these file systems. Eventually, the report will give out the result which shows the performance gap between these file systems and a primary conclusion will be given out what EXT could do to improve its performance in the perspective of category structure.

Keywords—Operating System,EXT , general ideas, background, plan(key words)

1. Introduction

Linux system has been a popular system since it was invented in 1991 due to many features such as open-source, high compatibility to many softwares [1].However, the file system of Linux has longer history than the system itself. The predecessor of Linux file system is Minix[2]. It is more than a file system but an Operating system, which was invented before Linux was born. Minix file system was once a successful file system at its time but an apparent weakness frustrated it. The partition is less than 64MB[3], but the limited spaces could not even fulfill the need of one file at current age. After Linux was invented, the urge of a new file system has prompted EXT’s born. In 1992 , the first version of EXT( EXT1) was launched in Linux[4]. Up to now, EXT the fifth version EXT5 has been published and it is still the main file system of Linux[5]. This report will give result and analysis mainly on EXT2/EXT3 version.

1. Background

Data Structure of EXT2/3

Linux system supports many kinds of file systems[6]. To discuss that, it is necessary to learn about the structure. Linux file system consists of two parts: virtual file system and concret file system[7]. Among them, virtual system is the entrance and user interface of file system while the other one is concrete file systems such as EXT2, Minix, sysV. The category structure was the subset of the concrete file system. Thus the category structure in this report refers to the category structure of EXT2/3 file system. The core of Ext2/3 is two kinds of inner data structure, among which one is Superblock while the other is Inode[8].Superblock is a form which contains important information of file system such as tags, capacity, numbers of index nodes(Inode). It is the global description of file system structure. In EXT2/3, Inode is the basic structure. Each node could be viewed as a file, the node contains information which concludes the description and the content of this file. All the nodes were kept inside a table called index table, and each item in the table would be arranged an unique identification called index number. Thus to find out the file is to find out the index in the index table.

Moreover, the category of EXT2/3 is a special file. Thus as a file, it is an Inode, but in this Inode it contains all the category items in this category, and each item is an Inode, too. The structure of Inode and superblock was shown in Figure 1.

Inode

As mentioned above, Inode is the basic data structure of EXT2/3. In Linux file system, all the files are Inodes even including the category. All the Inodes are unique, which means there are not identical Inodes in EXT2/3 file system.Inside an Inode there are 15 block-pointers, among which 12 are used as the direct pointers, another 3 pointers are used as indirect pointers. Data is kept in block called data block. The pointers will lead the file system to find out the data block which it searches for .Figure 2 shows out the relationship between the pointers and the data block of file.



Figure1.Ext2 data structure

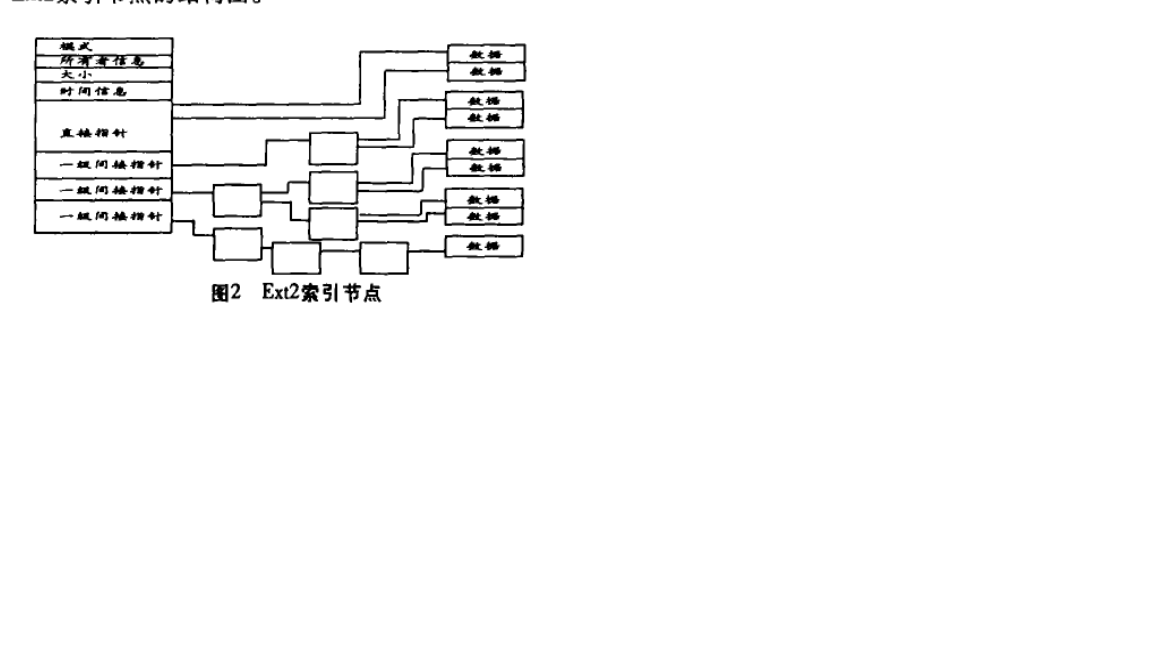


Figure 2 .Ext2 relationship between the pointers and the data of file

1. Analysis of reason for lower performance

No matter what the file system it is, the substance of storing data is to use the data structure of this file system to arrange the files and data. Thus to analyze the reason for the lower performance is to analyze the data structure of this file system. Assume a data block is 1024 bytes, which means it could store 1024 bytes data. Using the former 12 pointers, the maximum direct storing space can reach 1024\* 12 = 12kb. If we keep some data in this block, and if the data is less or equal to 12kb, then it will be so quickly to reach and open them, because they can be visited directly by the Inode. However, if the amount of data is more than 12kb, Inode will use a first-level indirect pointer to point at the first-level indirect block to assist store data. The first-level indirect storing space can store 256\*1024 =268KB data. If the first-level is still not enough, this Inode will use the second-level pointer and so on till the third-level pointer being used. However, the visiting speed will decrease with the indirect level increasing[9]. In addition , large amount of data will cause the lower performance of EXT2/3 file system.

Ⅳ.References:

1. J.Steven.(2016,Sep,9). *Twenty Years of Linux according to Linus Torvalds*[Online].Available:

https://www.zdnet.com/article/twenty-years-of-linux-according-to-linus-torvalds/

1. S.Andrew.(2004,May,20).*Some Notes on the "Who wrote Linux*[Online].Available:

https://www.webcitation.org/5sfayBi29?url=http://www.cs.vu.nl/~ast/brown/

1. Leemhuis, Thorsten (2008-12-23). *Higher and further: The innovations of Linux 2.6.28*[Online]. Available:

https://www.heise.de/

1. JiLe.Li. ‘File system performance optimization technology research’ Doctoral dissertation,Dept.Comput.Sci.,Univ.China University Of Petroleum,China,2014(in Chinese)
2. Phillips D. “A directory index for ext2” in *5th Annual Linux Showcase and Conference*. 2001,pp.173-218.