ALDM: Adaptive Loading Data Migration in Distributed File Systems

Zhipeng Tan, Wei Zhou, Dan Feng, and Wenhua Zhang

Wuhan National Laboratory for Optoelectronics, School of Computer Science, Huazhong University of Science and Technology, Wuhan City, 430074 China

This paper analyzes the problems of load balance caused by data access in parallel file systems and gives an accurate way to estimate the load of Data Servers. On the base of this evaluation, the paper proposes an adaptive loading data migration (ALDM) strategy to balance the load of data servers. Experiment results show ALDM has little impact on system performance during data migration, and the performance improves about 10% after data migration completed. Furthermore, ALDM also has good adaptability to various loads in different storage systems.

Index Terms—**Data migration, load balance, load detection, parallel file system.**

I. Introduction

With the rapid growth of distributed file systems, the issue of how to utilize system resources efficiently and improve the service capacity is getting more and more important. Although there are a lot of data distribution strategies [1]–[3], [6], [7], [9] to balance the loads of nodes [2], all of them have limitations whether they are based on access records or prediction. As the access requests become more and more complex and diverse, and the existing distribution strategies cannot balance the loads of nodes efficiently. Consequently, the system performance will decay severely due to hot data and hot nodes [3]. In parallel file systems, data is striped to multiple data servers [4], and the system performance for client and access bandwidth can be improved by concurrent access of data. But for typical parallel file systems, such as PVFS [5] and pNFS, in which data is striped to multiple data servers, there exists the "cask effect", when some of the data servers' load becomes heavy, the client's response time will increase greatly, and furthermore the system performance will decrease. Balancing the system load can effectively improve the service capacity of distributed file systems. According to existing work of load balance in parallel file systems, there are two major methods: one is to create data replica, and then to balance load by scheduling data visit [6]; the other is to migrate data [7] and schedule requests to low-load data servers. However, as a coin has two sides, the two methods show their benefits and defects, respectively, in the different application environments. Usually, it will obtain better a effect if the two methods are combined together. This paper studies the approach to balance the load of distributed file systems by using data migration for system performance improvements and proposes an algorithm of adaptive loading data migration (ALDM).

II. Related Work

Data migration generally addresses the problems, such as when data are migrated, where data are migrated, which data are migrated and how to complete the migration [8]. Evaluation of data servers' load is needed as load balance is a condition of data migration [9]. The load of a data server is usually determined by the data files stored in it. Existing work [10] shows that different types and sizes of files can generate different loads. References [11] and [12] compare the operation systems to different characteristics of accessing load and demonstrate that users have the tendency to access files. Therefore, researchers often measure the system load by accessing data. But in network file systems, the clients and data servers have caches, and it is not practical to measure data servers loads through access data of clients [13]. Reference [14] proposes a heterogeneous resource evaluation method that can effectively show the load of heterogeneous resources. In distributed systems, system performance will decrease when some kind of resource has the performance bottleneck [16]. Therefore, when doing an evaluation, we should not only use system load but also show the system resources bottleneck.

There are two kinds of driven conditions of data migration of data servers. The first method refers to the fact that the load of data server should satisfy certain threshold conditions. We can adopt a source initiative strategy when load of data server exceeds a threshold or adopt a server initiative when the load of data server is below the threshold. The other way is that when data servers load gap reaches the threshold, it introduces the data migration. According to existing work, when we measure the load of data server, we generally use the indicator of the data server, such as disk I/O idle time, or compute system comprehensive load through certain calculate methods. When the data migrate, we often select hot files and take visits divided by the file sizes as weight. When we choose migration destination data server, there are two principles: the load of data server is low or it did not participate in the process of data migration [17]. Different data migration goals may generate different approaches by which the destination data server is selected. Reference [18] proposes a radical data migration strategy that uses the maximize utilization of the storage system as the design goal. Reference [19] focuses on the migration process and proposes a method which ensures complete data migration within a certain period. Reference [20] presents that in current enterprise-class storage systems, online data migration is needed because of equipment damage and expansion, then it designs a data migration method which can complete data migration as

Manuscript received December 05, 2012; revised February 28, 2013; accepted March 01, 2013. Date of current version May 30, 2013. Corresponding author: Z. Tan (e-mail: zhipengtan@163.com).

Color versions of one or more of the figures in this paper are available online at http://ieeexplore.ieee.org.

Digital Object Identifier 10.1109/TMAG.2013.2251616