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Data Deduplication on Academic-based Private Cloud

Cho Cho Khaing[1], Zar Zar Hnin[2], Ei Ei Mon[3]
[1]Faculty of Computer Science, Myanmar
[2,3] Faculty of Computer Science, Myanmar

***Abstract*:**

Cloud computing provides scalable, low-cost and location-independent services over the internet. The services provided ranges from simple backup services to cloud storage infrastructures. The fast growth of data volumes has greatly increased the demand for techniques for saving disk space and network bandwidth. Cloud storage services choose a deduplication technique where the cloud server stores only a single copy of redundant data and creates links to the copy instead of storing actual copies. The distributed file system plays a very important role in cloud computing environments as well as it is necessary to store and manage data on low cost storage servers in which storage space can be reduced. Today's businesses are challenged with managing and protecting the ever-increasing amounts of data that is created on a daily and even hourly basis. To counteract this issue, this system proposes a method of multi-tire storage system using data deduplication. The advantage of multi-tire storage system can control and manage service levels to get better storage costs in different types of application environment. Data deduplication technique allows the cloud users to manage their cloud storage space effectively by avoiding storage of repeated data's and save bandwidth.

Keywords: **Cloud Computing, Multi-tier Storage, Deduplication**

1. Introduction

IT organizations worldwide are dealing with the tremendous growth of data. With the growth of capacity comes the complexity of managing the storage for that data. The data growth is coming from a wealth of data-intensive applications (e.g., business analytics), expanding use of high-performance computing (e.g., financial services and life sciences), collaboration and Web 2.0 applications, and content-rich data (e.g., digital images or video). In this data intensive environment, IT managers need to optimize the capacity and performance of storage systems while working to reduce complexity and lower costs. In addition to the continued growth in capacity, the accelerated use of virtual servers and desktops is rapidly altering the storage landscape. IT organizations worldwide are turning to virtualized environments to improve datacenter flexibility and scalability. This in turn drives implementation of networked storage solutions, which can create new pressures on storage performance as I/Os that were previously more distributed are aggregated into a smaller number of host interconnects. There are also implications for organizations' data protection processes and architectures to ensure that every virtual server is protected and that the storage has the same flexibility and resiliency as the virtualized server environment. Storage efficiency has been a goal of primary storage systems managers and an area of storage innovation for some time. Disk storage system techniques such as thin provisioning, space-efficient snapshots, automated tiering, and virtual storage management have all been developed to help IT managers improve storage system utilization and efficiency[9]. More recently, data deduplication and compression technologies for primary storage have been gaining attention in the quest for improved storage efficiency. Deduplication is one of the few IT solutions that cuts costs quickly and improves service levels. With it, organizations can reduce storage expenses without compromising data protection.

This paper presents the efficient storage system in private cloud. This approach has been designed to use over virtualized storage system. The idea of the proposed system is to exploit the use of virtualization technology to avoid unnecessary storage purchases and reduce storage space for addressing large volumes of data handling problem.

2. Literature Survey

Much work on deduplication focused on basic methods and compression ratios, not on high throughput. Early deduplication storage systems use file-level hashing to detect duplicate files and reclaim their storage space [4, 7, 14]. Since such systems also use file hashes to address files. Some call such systems content addressed storage or CAS.

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Since their deduplication is at file level, such systems can achieve only limited global compression. Venti removes duplicate fixed-size data blocks by comparing their secure hashes [12]. It uses a large on-disk index with a straightforward index cache to lookup fingerprints. Since fingerprints have no locality, their index cache is not effective. When using 8 disks to lookup fingerprints in parallel, its throughput is still limited to less than 7 MB/sec. Venti used a container abstraction to layout data on disks, but was stream agnostic, and did not apply Stream-Informed Segment Layout. To tolerate shifted contents, modern deduplication systems remove redundancies at variable-size data blocks divided based on their contents. Manber described a method to determine anchor points of a large file when certain bits of rolling fingerprints are zeros [10] and showed that Rabin fingerprints can be computed efficiently. Brin et al. [6] described several ways to divide a file into content-based data segments and use such segments to detect duplicates in digital documents. Removing duplications at contentbased data segment level has been applied to network protocols and applications [8, 3, 11, 13] and has reduced network traffic for distributed file systems [2,5]. Kulkarni et al. evaluated the compression efficiency between an identitybased (fingerprint comparison of variable-length segments) approach and a delta-compression approach [1]. These studies have not addressed deduplication throughput issues.

3. Academic-based Private Cloud infrastructure of Proposed System

The main focus of the work is to build storage server using pc cluster for academic based private cloud. Cloud infrastructure is implemented by using Ubuntu Enterprise Cloud (UEC) architecture. The UEC is powered by Eucalyptus, an open source implementation for the emerging standard of the Amazon EC2 API. Physical architecture is shown in **Figure 1.**

Physical network architecture is based on the backbone network. This architecture consists of front-end infrastructure, back-end infrastructure and storage server. The front-end infrastructure contains Cluster Controllers (CC), Cloud Controller (CLC). The back-end infrastructure consists of Node Controllers (NC). The storage server is made up of many of PC cluster node and which is the main focus of our work.

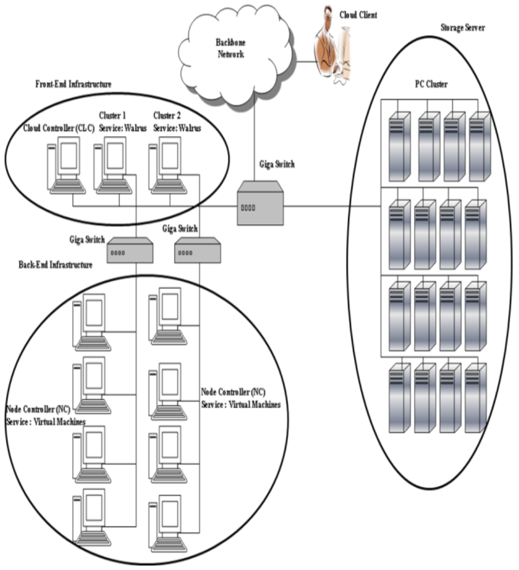

Figure 1. Physical infrastructure of private cloud

3.1 Front-end Infrastructure

The front-end infrastructure contains cluster Controllers (CC), Cloud Controller (CLC). There are two Cluster Controllers: cluster 1 and cluster 2 and each cluster configure Walrus Storage Controller (WSC) services. And then, Elastic Block Storage Controller (EBS) runs on the same machines as the Cluster Controller and is configured automatically. It allows to create persistent block devices that can be mounted on running machines in order to gain access to virtual hard drive.

The Cluster Controller (CC) operates as the go between the Node Controller and the Cloud Controller. It will receive requests to allocate virtual machine images from the Cloud Controller and in turn decides which Node Controller will run the virtual machine instance. All the virtual machine images were stored in the Walrus Storage service. The actual storage behind the Walrus was implemented as iSCSI volumes hosted on Storage Server. The Cloud Controller (CLC) is providing the interface with which users of the cloud interact. The CLC contacts with the Cluster Controller (CC) and makes the top level choices for allocating new instance.

3.2 Back-end Infrastructure

Back-end infrastructure consists of Node Controllers (NC). The Node Controllers (NC) software runs on the physical machines on which virtual machine instances will be instantiated. These Virtual machine instances has own IP address on Node Controller. Each of Node Controller has a local storage device. The local storage was only used to hold virtual machine image at run time and for caching virtual machine instances. When a virtual machine is terminated, the storage on the virtual machine instance is released and storage in the storage server pool as virtual machine image.

4. Data Deduplication

Data deduplication has become an important storage technology in the past few years. Storage solutions, either based on deduplication or with deduplication as a feature, are now available across the entire spectrum of storage offerings from many vendors, large and small. Data deduplication identifies and eliminates redundant data. It can be performed at the file, block, or byte level. The opportunity to find and eliminate redundancy becomes greater with more granular examination. In secondary storage processes, such as backup, data is initially seeded on the secondary storage device and all subsequently written data is examined for redundancy. Replicate data is not stored twice; instead, a pointer to the stored duplicate data is written (which takes up significantly less space).

4.1 Hash-Based Approach

A hash-based de-duplication system consists of three components - file chunking, hash value generation, and redundancy detection. When a new file arrives, the de-duplication system breaks entire file into many small blocks as known as chunks. Then the system uses hash algorithm, like Secure Hash Algorithm - 1 (SHA-1) to generate the unique signatures to present these chunks. Now, the de-duplication system can more easily and accurately compare these signatures with its database or lookup table to identify these small chunks are new data or redundant data. During the comparisons, if the system cannot find any signature matching in its lookup table or database, then the system assumes these chunks are new data and stores them. If the system detects a signature matching, then it creates a logical reference to the duplicate data whose copy was already stored in database.

4.2 Block-Level Deduplication

Block-level deduplication (fixed and variable) requires more processing overhead but allows for better deduplication of files that are similar but slightly different. All blocks are shared except for the different ones. This approach is very useful with virtual machine images, for example, which mostly include a large copy of the guest operating system with some blocks that are unique to each virtual machine.

4.3 Deduplication Process

```
    Procedure Deduplication Process
BEGIN
While (input data)
Divide input data into block
Generate hash value (block_id)
Find the redundant data using hash value
End while
END
```

Figure 2. Algorithm of Deduplication Process

5. Tier Storage Service Levels

The Tier 1 storage offers quick response times and fast data transfer rates. It is a great solution for organizations that need to effectively store high-performance data that demands high availability. Services of Tier 1 can be viewed from any cloud member. Tier 1 services such as notice board, news and calendar service. These service levels do not need to provide security system. Some of the Tier 2 and Tier 3 services have limited. Only authorized person can access it. This services need to support security policy. Tier 2 services are photo sharing, comments, prints, download, upload, appointment with supervisors. Tier 3 services such as software access service, mail service and multimedia.

```
  Procedure Tier Analyzer Process
  BEGIN
  Set (tier1, tier2 and tier3) data
  I=Input data
  B: the array to store the input data and tier
     number
   For k=tier 1 to tier 3 do
     If I match k then
        Set B= (I, k)
        Deduplication process (B)
        Store data according to tier number
        Exit
End if
     End for
     END
```

Figure 3. Algorithm of Tier Analyzer Process

6. Conclusion

Data will continue to grow for IT managers, and they will continue to look for every opportunity to improve their storage utilization and efficiency. Data deduplication is an emerging trend and secure deduplication is one of the most important concerns for users. This proposed system is expected to be reduced hardware costs and management overhead. Multi-Tiered Storage System will control and manage different types of service levels as well. By using Deduplication process will save space, improve our data protection and increase speed. Reducing the amount of data redundancy will make backups more efficient and quicker as well. Thus, Network bandwidth will also improve after de-duplication.

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