Chapter 1

Commercial and Distributed Storage Systems

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ABSTRACT

Distributed storage systems are becoming the method of data storage for the new generation of applications, as it appears a promising solution to handle the immense volume of data produced in today’s rich and ubiquitous digital environment. In this chapter, the authors first present the requirements end users pose on Cloud Storage solutions. Then they compare some of the most prominent commercial distributed storage systems against these requirements. Lastly, the authors present the innovations the VISION Cloud project brings in the field of Storage Clouds.

INTRODUCTION

Distributed storage systems are becoming the method of data storage for the new generation of applications - Web applications by companies like Google, Amazon and Yahoo!. There are several reasons that explain the increasing trend towards distributed processing. On one hand, programs should be scalable and should take advantage of multiple systems as well as multi-core CPU architectures. On the other hand, Web servers have to be globally distributed for low latency and failover. Object systems differ from file systems in the data model and access semantics they provide. Distributed object stores support wide distribution of data and access to data with high availability, even in presence of frequent node failures. They support data storage cloud services in which data is read and written by a wide variety of client applications running anywhere and typically using HTTP interfaces to access the storage service and their data. Several main differences in the characteristics of distributed object stores compared to file systems are:

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- **Flat namespace**: Each object is addressed individually and independently of other objects, eliminating the hierarchical directory structure of file systems. With a flat namespace, each operation affects a single object, which helps keep consistency in widely distributed systems. Object metadata support provides some data management capabilities that compensate for the absence of directories. Some object stores provide the notion of containers, or buckets, that act as collections of objects and divide the namespace into multiple ones, also serving as a means of managing data and isolation between different data sets and multiple clients.

- **Fixed content**: Objects are typically written as a whole, rather than updated at the byte range level. This also helps keeping data consistency in the presence of multiple geographically distributed writers, while keeping the object stored highly available for read and write.

- **Relaxed consistency models**: Storage clouds consisting of distributed object stores deploy an eventual consistency model, meaning that when no node and network failures occur, eventually all nodes will have the same view of the data.

- **Modern distributed object stores**: Typically built for world-wide spread with nodes distributed over a WAN. Data redundancy is typically supported through replication rather than RAID. Replicating data across distant locations also improves the availability and latency in access to the data. Each object storage cloud service has its own HTTP based API, and each API evolves over time by adding more features support through the API. The flexible APIs are developer-friendly and allow for rapid enhancements of the service. On the other hand, lack of standardization in this area results in lack of interoperability and the data lock-in problem. Providing storage as a cloud service introduces a new ICT delivery model for storage. Businesses and individuals can consume flexible, variable and unlimited amount of storage without acquiring hardware, managing and maintaining it, paying per use for storage consumed “on demand”.

In this chapter, we first present the requirements end-users pose on cloud storage services. Then we provide a high-level overview of the most prominent commercial offerings in cloud storage and compare them against the requirements set out. Lastly, we briefly present how the innovations of VISION Cloud compare to the presented commercial solutions.

**REQUIREMENTS**

Within the context of the VISION Cloud project a number of requirements for a storage service have been identified. These can be basically broken down to the following categories:

- Basic access to the storage and interface requirements. The service should support the Create, Read, Update and Delete (CRUD) operations on the data objects and metadata through a standard interface such as CDMI.
- Requirements having to do with the efficient tagging of data with metadata, as well as the efficient search and retrieval of objects based on these metadata.
- Computational requirements. The storage service should allow for computations to be defined and executed on the stored objects and their metadata.
- Security and Compliance requirements. The issue of security is of major importance in storage clouds. This is not limited to providing encryption mechanisms, but also