Design and implementation of private cloud storage platform based on OpenStack

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Abstract—**With the rapid growth of the internal volume of enterprise data, it causes many problems in terms of storage, such as the lack of adequate hardware storage devices, high maintenance costs, and incomplete storage environment and so on. Cloud Computing technology can provide customers with the corresponding demand services that can effectively address these issues. Swift framework in OpenStack Cloud Computing platform provides an object storage solution could create redundant copies. It has the advantages of high data persistence, completely symmetrical system architecture, and unlimited scalability, no single point of failure, simple and based on reliable components. Thus, it is a feasible way to realize cloud storage. Therefore, a private cloud storage platform has been designed and implemented based on Swift framework in this paper, and Python framework Django was adopted to build up the website system to complete the tasks of creation, upload and download of enterprise data files through Web-based method to prove system's feasibility.**

Keywords—component; formatting; style; styling; insert (key words)

I. Introduction

How to efficiently store and manage massive internal information is one of the important issues that various enterprises are facing on. High-end storage array provides high-capacity, high-performance storage, but its unit costs are too expensive; low-end storage devices have limited capacity, equipment sets to be stacked to process large data which result in the complexity of management and maintenance. Therefore, elastically expansion, safe, reliable, inexpensive data storage solution and the corresponding storage service have become the focal point of the enterprise. A private cloud storage platform has been designed and implemented based on Swift framework of the OpenStack open source cloud computing platform in this paper, and Python framework Django was adopted to build up the website system. The enterprise data files could be created, uploaded and downloaded in the cloud storage via the Web to meet the needs of remote storage, backup, archiving and information share for the enterprise users and personals.

II. Cloud Computing and object storage

A. Cloud Computing

Cloud computing is a computing manner based on the Internet that can provide corresponding hardware and software resources and information according to the needs [1]. Cloud Computing virtualize the infrastructures of computing, networking, storage and others to form a dynamic, measurable shared resource pool, and provide a super computing model to all types of users in the form of controlled services through a management platform.

In the three cloud deployment modes of Cloud Computing, public cloud, private cloud, hybrid cloud. The public cloud attracts a large number of users with its low price and flexible resilient strategy. But for many enterprises, the private cloud provide more efficient and personalized flexible computing resource allocation capability, and could more effectively use the existing internal IT infrastructures resources to build the cloud platform that more in line with the business needs [2]. And the IT personnel in the enterprise could effectively control data, security and quality of service of the private cloud platform. Thus, the private cloud has become the main choice for enterprises [3].

B. OpenStack Cloud Computing platform

OpenStack is a Cloud Computing platform that developed by hosting service provider Rackspace and NASA to help cloud service providers and enterprise to build cloud infrastructure services [4]. OpenStack project could be thought as a cloud operating system. Any organizations or individuals can build their own cloud computing environment (IaaS) based on OpenStack.

OpenStack adopts modularized designing. Its core modules are Nova (computing service), Swift (object storage service) and Glance (mirror service) [5]. Computing service is a control unit of cloud platform which provides management tools to manage the instance's running, networks and users. Object storage service is a scalable object storage system that supports a variety of applications, such as data replication and archiving, video or image and other various types of massive data access services. Mirror service is a virtual machine (VM) image storage, query and management system.

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C. Object storage

Object storage combines the advantages of file storage and block storage, which has advantages of fast data reading and writing of block storage and distribution of file storage. The main design idea of object storage is separation the data path (data read and write) and control channel (metadata), and store data in the object storage device (Object Based Storage Device, OSD) [6]. Storage access is provided by the object interface instead of conventional block interface. Each object storage device has some intelligent to automatically manage data distribution. Object storage system provides fast retrieval mechanism to solve the deficiencies and limitations of traditional storage methods in massive data processing, so that the problems of massive information storage, heterogeneous data flexible sharing, storage system scalability, and information security are all easy to be solved [7].

Customers could store and access data through a Web interface or RESTful form interface, and also could make use of leasing space and interfaces to develop all kinds of applications sites, personal and enterprise-class data backup systems and other large-scale data-based services. Object storage service support elastic expansion, customers can use the storage resources on demand according to their own business development, and pay the amount of actual using.

D. Swift framework

Swift is the open source storage subproject of OpenStack. It uses the common servers to build redundancy, scalable, distributed object storage cluster, and the storage capacity could reach up to PB-level [9]. Swift adopts the consistency hash technology and data redundancy in software design, and achieves high availability and scalability at the expense of the data consistency.

Swift adopts the distributed system architecture design of completely symmetry, resource-oriented. All components can be extended to avoid single point of failure that could be spread and affect the entire operation of the system; communication method uses the non-blocking I/O model to improve the system throughput and response ability. System framework of Swift was shown in Fig. 1, the storage system was mainly constituted by the three parts: the proxy node (Proxy node), authentication node (Auth node) and a number of storage nodes (Storage nodes) [9].

Fig. 1. Deployment architecture of Swift
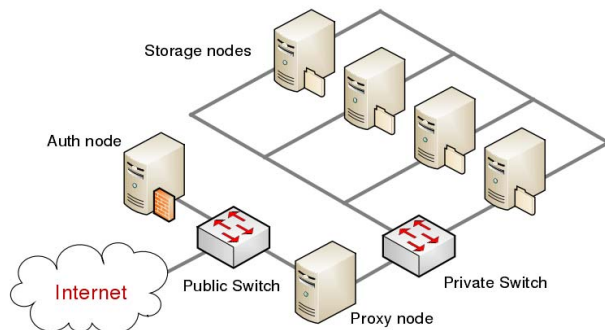
- Proxy node: the proxy node provides service process for the public network, responsible for the other components' communication with each other, and to provide external REST-full API in accordance with standard HTTP protocol specification. The Proxy server processes each request, queries the place of accounts, containers or objects and forwards the request correctly. Its physical form can be a single server, or it can be extended to a proxy server cluster to improve the load capacity of the system.

- Auth node: the authentication node could achieve a unified authentication management by deploying the KeyStone service. Keystone is the official component that provides authentication, token, directory services and policies services.

- Storage node: three storage servers could be deployed on a storage node, the account server, container server and object server. The account server processes container list; the container server processes the object list, tracks the number of objects and usage statistics of container; the object server operates and manages the object stored in the local disk [10].

III. DESIGN AND IMPLEMENTATION OF PRIVATE CLOUD STORAGE PLATFORM

A. Overall design concept

The private cloud storage platform based OpenStack mainly provides user accessing to complete the functions of authority certification, operation and management of storage object. The platform was designed based on three-tier stateless connection REST software architecture. The presentation layer is the direct user interface, and was built based on Python Django framework; Web server layer is the middleware to handle user accessing; the data layer is the distributed object storage node. The Swift platform provides an open REST-full API as the programming interface for a variety of programming languages that allows users to carry out operation such as accessing, modifying, creating and deletion of different storage resources according to development needs.

B. System Architecture

The private cloud storage platform was constituted by the user management module, file management module, and resource management module and so on. The platform's system architecture was shown in Fig. 2.

- User management module provides functions of user registration, user login, and user logout and user authorization. User should fill in the necessary information to register at first, and after the successful activation, user can set up your personal information; manager of the platform could complete the frozen, restore or delete operations for users, and could authorize user based on its roles. User login module is mainly check the user's legitimacy access to the system and assigned function modules can be accessed to user in accordance with its authorization.

- File management module provides functions of uploading, downloading, deletion of files and folder management. The file uploading function mainly realizes the function of uploading all kinds of enterprise files such as video files, music files, image files, and documents files and save them to cloud storage. The file downloading function is to achieve the legitimate users accessing the system and downloading the required files or documents from the cloud storage. Files deletion function is mainly used for authorized users to manage and delete relevant documents in cloud storage. Folder management function is to achieve classification management of the files and folder management of creation, deletion, and modifying.

- Resource management module provides the functions of system metadata management, container management and objects management, supports container operations of creation, modifying, deletion and others, and supports operations of storage object of uploading, downloading, deletion, and copy, and provides the function of object version management.0

Fig. 2.   Functional architecture of the private cloud storage platform
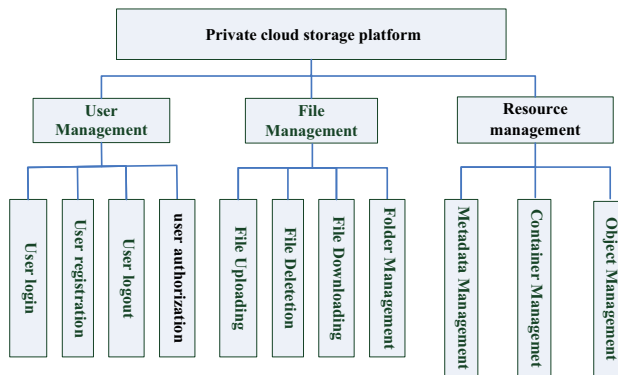
IV. Platform deployment and system development

Swift framework provides the API interface for Java, C #, PHP, Python and other mainstream languages, users can use the above interfaces to access storage resources through the RESTful way. In this paper, the traditional network storage in enterprises was replaced by the cloud storage. A website system was built by using the Django Python framework to realize the web version client for accessing the cloud data storage. The basic functions such as file creation, uploading, and downloading was realized to verify the performance of OpenStack Object Storage and operation availability of the management platform. Django is a free and open source web application framework, written in Python, which follows the model-view-controller (MVC) architectural pattern [11]. Django's primary goal is to ease the creation of complex, database-driven websites. Django emphasizes reusability and "pluggability" of components, rapid development, and the principle of do not repeat yourself. As shown in Fig. 3, three servers, including a control node, a network node and a compute node were deployed in a lab environment, of which the Swift framework was deployed on the Compute node.

As shown in Fig. 4, the private cloud storage platform could upload and store the pictures, audio and video and other unstructured data to the cloud. Users utilize the account and password authentication information to connect via a standard API interface to object storage system, and the file objects could be uploaded, downloaded, and deleted. Experiments show that the private cloud storage platform can provide storing and accessing unstructured data based on the OpenStack Object Storage services, and the cloud storage platform functions well.

V. Conclusions

Based on the research foundation of OpenStack object storage service and its associated open source technologies, we designed and implemented a private cloud storage platform. Swift framework in OpenStack Cloud Computing platform has the built-in mechanism of redundancy and fault tolerance that making data loss rate is very low; private cloud was deployed in the same enterprise network with the users that making the higher network file transfer speed; private cloud was located inside the firewall that making the smaller probability of attack, and the stored data are invisible among different groups of users that has the higher data privacy. Therefore, the private cloud storage platform based on OpenStack can quickly implement business management, and provide flexible services, effective support to carry out object storage services to better meet the business needs of the data file storage.

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Fig. 3.   Deployment of the OpenStack Computing platform
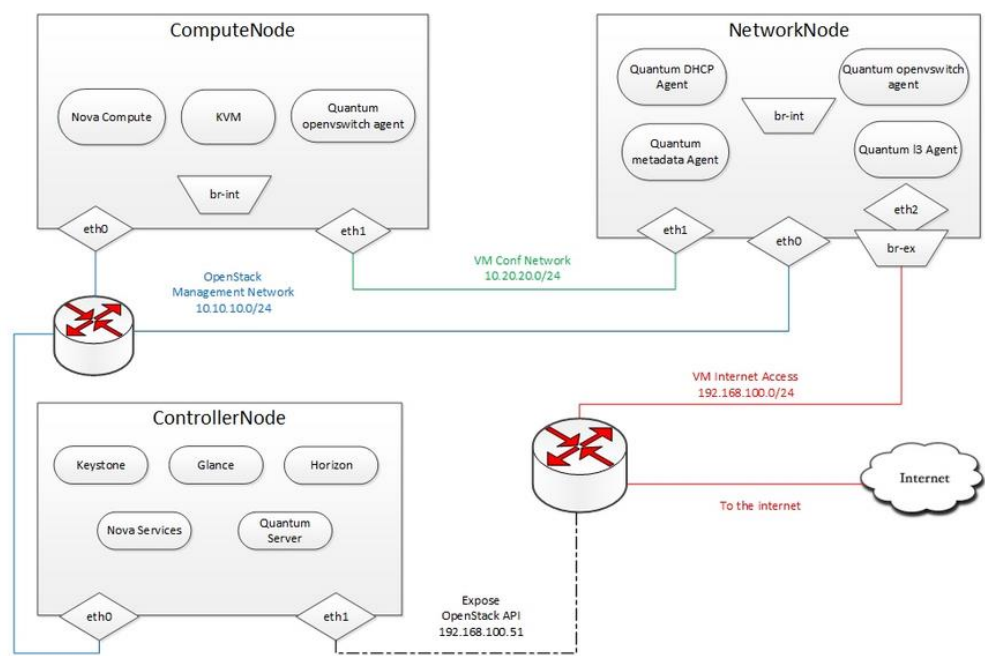
Fig. 4.   system operation interface

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