A new structure for software defined storage system management

Hongxia Wen[1]

[1] Shengma Intelligent Technology Co., Ltd
zty_urb_iot_9@163.com

Abstract. The storage system needs to adapt to the needs of application scenarios and provide flexibility for optimization according to application scenarios. This flexibility requires a software defined management system. Memory and disk are readable and writable, and holographic optical storage is read-only. The storage of this hybrid structure needs to be flexible and not equipped with specific types of storage according to data attributes. At the same time, it needs to be transferred in different storage media according to the cold and heat characteristics of the application data. Design software defined storage scheme for data Lake AI application. Verify the flexibility and performance index of SDS.

Keywords: SDS, FPGA, File system.

1 Instruction

There are three main storage modes: semiconductor storage represented by solid-state disk[1], magnetic storage represented by mechanical hard disk and optical storage represented by Blu ray storage. At present, the market share of solid-state disk is expanding steadily and gradually replacing the mechanical hard disk. Solid-state disk has been widely used as the underlying storage device in large-scale storage systems, and there is a trend of flash memory[2]. It has the advantages of faster reading and writing speed, but has the disadvantages of limited erasure times and charge loss. It is not suitable for long-term data storage, and it also faces the problem of limited storage density (550 GB / in2). The storage technology based on magnetic storage mechanism not only has the problem of limited service life[3] (hard disk 5 years), but also the data is stored in the two-dimensional plane of the disk surface, and the storage density (735 GB / in2) has approached the theoretical limit of its technology. Holographic optical storage has obvious advantages in data long-term storage cost and energy consumption, but its disadvantage is relatively slow.

From the development process, holographic storage technology has made encouraging achievements in basic theoretical research and engineering prototype development, and the key technologies still need further innovation and breakthrough.

EAI Urb-IoT 2021, December 20-21, Shenzhen, People's Republic of China

DOI 10.4108/eai.20-12-2021.2315030

1.1 Ideal storage system

With the advent of the data age, the demand for storage capacity is higher and higher. At the same time, hard disk technology has also encountered a technical bottleneck[4], and Moore's law with increasing storage density has also failed, which has brought dawn to the revival of volume holographic storage. Facebook's comparative study of various current storage technologies also shows that optical storage has the most advantages in long-term data storage cost and energy consumption. In January 2016, it announced to cooperate with Panasonic to develop luminous storage technology to store data (cold data) that is not used for a long time and rarely accessed, so as to reduce the storage cost of massive data.

Of course, this is mainly the change of the external environment[5]. Whether holographic storage technology can respond to the call of the times and become the mainstream of the next generation of storage depends on the development of its technology, especially the breakthrough of key technologies.

Therefore, the ideal storage system is a hybrid storage system of flash memory and holographic optical storage system[6]. In order to meet the future market of huge data applications, especially for data-driven services, the hybrid system of flash memory and optical storage needs to solve the three-level problems of underlying channel bandwidth, huge file management file system and software defined storage system.

2 High performance distributed file system

The mechanism of separating data and metadata is adopted to improve the system performance. Metadata is stored on MDS. MDS provides the metadata of the whole file system to client, manages the namespace of the file system, maintains the directory structure and user permissions of the file system, and maintains the data consistency of the file; The file data is stored on the OST, which processes the client data request and communicates with the lower physical storage device.

Cluster single point MDS. The horizontal expansion metadata cluster can solve the problem of single MDS. First, it relieves the pressure of CPU and memory; Second, multiple MDS can also store more metadata information; Third, the processing capacity of metadata can also be expanded horizontally, so as to improve the performance of concurrent access to massive files.

This scheme verifies the combination of static subtree and directory hash. There are three elements to this approach:
The root directory is in a fixed MDS node.

Each level of directory will hash and select MDS again according to the entry name to ensure the ability of horizontal expansion.

When storing the metadata of files under the directory, it is not hashed, but at the same node as the parent directory to ensure a certain degree of metadata locality.

This approach brings two benefits. One is to realize the distributed storage of metadata, so that the number of 10 billion files can be supported by expanding the metadata node. The other is to ensure the metadata retrieval performance to a certain extent and reduce metadata retrieval and operation on multiple nodes.

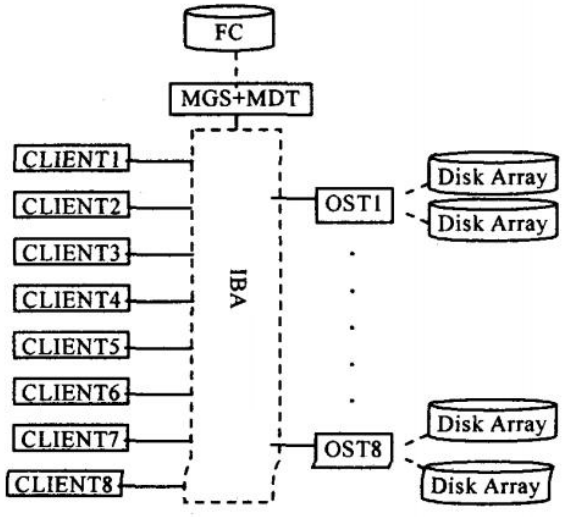

Fig. 1. File system architecture

2.1 Software defined storage system (SDS) management scheme

Data centers are increasingly demanding flexibility and speed, and data center application performance is closely related to resources such as computing, network and storage. An overall smart organization and arrangement scheme for the data center can break the limitations of computing, network and storage, and significantly increase QoS and user experience. The product is mainly aimed at AI applications on the data lake. Therefore, it is necessary to shield the characteristics of the underlying storage, understand the data attributes and reasonably organize and store the data through software definition or automatic detection.

Effective and flexible management scheme is very important for software defined storage system. Due to the mixing of hot and cold data and the hot spot of holographic optical storage (large amount of data read and slow write), it is necessary to explore the management strategy and scheme in the storage system defined by the design software.

As an enterprise's data Lake technology selection, the first problem to be considered is: what kind of storage medium or storage system to use as its own data Lake solution. As we all know, different storage media or storage systems have different advantages and disadvantages. For example, some storage systems have better response time for random reading, some systems have better throughput for batch reading, some systems have lower storage cost, some systems have better scalability, and some systems have more efficient structured data organization... Accordingly, some of these indicators are just what some storage systems are not good at. How can they enjoy the advantages of all storage systems Avoiding the disadvantages of all storage systems has become the primary issue to be considered

for cloud data Lake services. In theory, it is impossible to solve this contradiction once and for all. The smart approach is to provide a logical storage solution for the, and then flexibly migrate the data requiring different access characteristics in various underlying storage systems. Give full play to the advantages of each storage system through the ability of convenient data migration (, and data format conversion). Conclusion: a mature data Lake must be a logical storage system, and its bottom layer is composed of multiple types of storage systems.
The overall goal of SDS is to achieve a prototype, verify key indicators and technologies, decouple requirements from the underlying infrastructure, and achieve indicators in typical application scenarios.

Abstraction of workload take Web programs generally include a web server, a database, and an application server. This software pattern is described in a descriptive language format of JSON, and then the engine of the unified control plane in the middle parses the language, and then arranges the underlying resources for the workload organization.

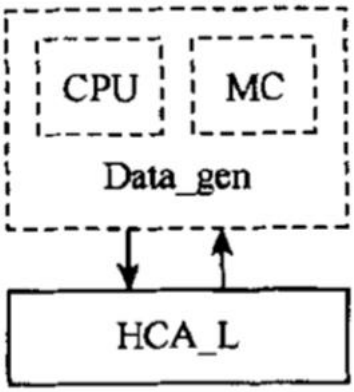

Fig. 2. Application on FPGA

From a storage perspective, this framework can create flexible storage semantics. For example, applications can specify the size of storage volumes, storage service types, and other related policies. Therefore, this framework enables program developers and system managers to explicitly specify their requirements for the underlying storage. This user level storage requirement can also change in the life cycle of user programs, bringing greater flexibility.

Resource abstraction is to abstract storage resources into a resource pool, and then manage and allocate them according to workload requirements. In flash memory and holographic optical storage, it is necessary to consider the mismatch of read-write time caused by media differences and the requirements of read-only information and read-write information.

At the same time, some devices need to be virtualized so that users do not care about specific media properties. The magneto-optical array method (oraid) proposed by Liu Jianmei et al. [1] configures the disk module and the optical module in the

same data storage layer, in which the optical module is hidden behind the disk module, and uses the mapping database to establish a corresponding relationship between them, so that users can't see any operation on the optical module.

In short, this framework provides an abstraction of storage resources, which can achieve good storage resource utilization, improve operation performance and reduce the complexity of storage system.

Refine requirements, schedule and map resources according to the differences between storage media resource attributes and data attributes (read-write, permanent storage, etc.).

The function of unified control plane in this framework is to organize and arrange resources according to the user's request. For the storage request, it is to parse the storage request and pass it to the SDS module to achieve the purpose of resource mapping.

For each storage resource creation request, a "service type" label is required, representing special requirements for storage provisioning, such as RAID level or error recovery profile. Each service type represents a set of stored configurations. For example, for the "Platinum" service type, it may require low latency. The storage volume created by such workload is more likely to be placed in SSD than ordinary disk. In addition, if there are many SSDs available to form a resource pool, the framework will also analyze the utilization of devices in the SSD resource pool, and then place the newly created storage volume on one of the SSDs (which will have the least performance impact).

Storage information lifecycle management (ILM). This is because the value of data changes dynamically in its life cycle. For example, the value of e-mail data is the highest at the beginning, and then the e-mail becomes more and more worthless over time. Therefore, the goal of ILM is to put the right data on the right storage tier at the right time. This is the storage tiering Technology (the IO tier is determined according to the historical IO behavior). Our framework enables applications to control the tier of storage according to their unique requirements. For example, specify a service type as high tier and lower tier, and then automatically execute certain tier policies at certain IO thresholds.

3 Software defined storage system (SDS) management scheme

Data centers are increasingly demanding flexibility and speed, and data center application performance is closely related to resources such as computing, network and storage. An overall smart organization and arrangement scheme for the data center can break the limitations of computing, network and storage, and significantly increase QoS and user experience. The product is mainly aimed at AI applications on the data lake. Therefore, it is necessary to shield the characteristics of the underlying storage, understand the data attributes and reasonably organize and store the data through software definition or automatic detection.

Effective and flexible management scheme is very important for software defined storage system. Due to the mixing of hot and cold data and the hot spot of holographic

optical storage (large amount of data read and slow write), it is necessary to explore the management strategy and scheme in the storage system defined by the design software.

As an enterprise's data Lake technology selection, the first problem to be considered is: what kind of storage medium or storage system to use as its own data Lake solution. As we all know, different storage media or storage systems have different advantages and disadvantages. For example, some storage systems have better response time for random reading, some systems have better throughput for batch reading, some systems have lower storage cost, some systems have better scalability, and some systems have more efficient structured data organization.

Accordingly, some of these indicators are just what some storage systems are not good at. How can they enjoy the advantages of all storage systems Avoiding the disadvantages of all storage systems has become the primary issue to be considered for cloud data Lake services. In theory, it is impossible to solve this contradiction once and for all. The smart approach is to provide a logical storage solution for the, and then flexibly migrate the data requiring different access characteristics in various underlying storage systems. Give full play to the advantages of each storage system through the ability of convenient data migration (, and data format conversion). Conclusion: a mature data Lake must be a logical storage system, and its bottom layer is composed of multiple types of storage systems.

4 Conclusion

The principle of magneto-optical hybrid storage technology is to store data on all solid state hard disk (SSD), disk (HDD) and optical disk library respectively according to the heat. SSD or HDD array constitutes a data buffer to provide high I / O (input / output) bandwidth and high scalability. Optical disk library provides safe and reliable long-term storage service with low energy consumption, and data can be intelligently migrated between the three with the change of heat.

The advantages of volume holography are volume storage and parallel reading and writing. The hybrid storage scheme of hybrid flash and volume holography is studied. Through direct connection of communication interface, simplification of hierarchical structure and optimization of message format, the interconnection of CPU, ordinary flash memory and holographic optical storage is designed and realized based on FPGA. Before the prototype of holographic storage device is available, multiple cabinets can be used to simulate the parallel read-write and bandwidth of holographic optical storage., Choose to implement the iniiniiniband interface in the FPGA chip and conduct the network delay test to facilitate the connection with the storage device in the follow-up work.

References

1. Dang Sheng Su,Gabriele Centi. A perspective on carbon materials for future energy application[J]. Journal of Energy Chemistry, 2013, 22(02):151-173.
2. Muqiang Jian, Yingying Zhang, Zhongfan Liu. Natural Biopolymers for Flexible Sensing and Energy Devices[J]. Chinese Journal of Polymer Science,2020,38(05):459-490.
3. EMMANUEL KOBINA PAYNE. Design of Distributed Energy Resources Integration for Active Demand Power Delivery as A Microgrid System[D]. JiangSu university, 2019.
4. Jingjing Wei. Research on Cross-Border e-Commerce Operation Model Innovation Based on “Internet +”[A]. Institute of Management Science and Industrial Engineering.Proceedings of 2019 2nd International Workshop on Advances in Social Sciences(IWASS 2019)[C].Institute of Management Science and Industrial Engineering: Computer Science and Electronic Technology International Society ,2019:5.
5. Xiaojun Jia, Menggang Li. An index of financial safety of China[J]. Journal of Industrial Engineering and Management, 2015, 8(2):
6. Huanguo Zhang, Wenbao Han, Xuejia Lai. Survey on cyberspace security[J]. Science China(Information Sciences), 2015, 58(11):5-47.