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Big data storage configuration and performance evaluation utilizing NDAS storage systems

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Abstract

Recently, a large amount of multimedia data is rapidly increasing due to cloud activation. For this reason, there is a need for a technique capable of handling large amounts of data and large storage devices. In this way, a network storage device such as a NAS or a SAN is used to configure a large-capacity storage device in a network environment. In this paper, a large capacity storage device is constructed by using network direct connection storage device. We performed benchmark experiments to verify the scalability of the constructed storage devices using network direct attached storage.

Keywords: Big data; NAS; Network storage; SAS

1. Introduction

IDC, a market research and consulting firm, estimates that by 2015, data volume will reach 7.9 ZB and will grow at an annual rate of 40 ZB in 2020 1. As the amount of data to be managed increases, so does the storage capacity. Big data storage technology is being studied to manage and store large-scale data efficiently. Also, several distributed processing frameworks such as MapReduce and Spark have been studied to find meaningful results based on Big Data 2–6. When the distributed processing framework is used, frequent communication occurs between server nodes because it uses a lot of distributed data. Therefore, the biggest performance degradation factors of the Big Data Distribution Processing Framework are network and storage performance.

In general, a NAS or SAN is used to configure a network-based mass storage device 7,8. However, there is a problem in that NAS and SAN have a limited performance and a significant cost for constructing a large-scale storage device. To solve this problem, a high-performance storage device can be configured at a low cost by using a network direct attached storage (NDAS). Unlike conventional network storage devices, NDAS is less expensive than network

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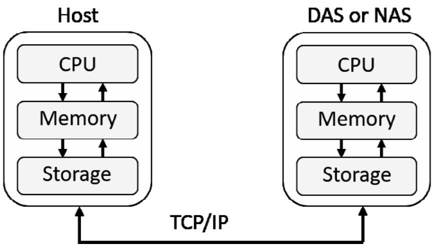
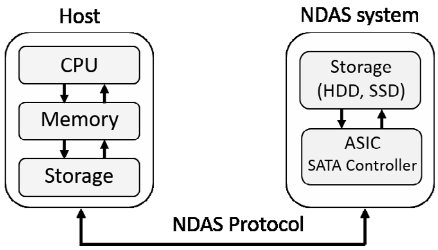


(a) Configuration of DAS and NAS.



(b) Configuration of NDAS.

Fig. 1. Result of fileserver workload.

storage devices such as NAS, which contain CPU and memory, because there is no CPU and memory 9. In addition, since data input/output is directly performed using a self-developed protocol without using the TCP/IP protocol in the communication through the network, it is possible to minimize the input/output performance deterioration due to the network stack.

In this paper, we describe a prototype of a large-scale storage system using NDAS and conduct performance and scalability experiments required for the storage system. Experiments have confirmed that NDAS is suitable as a big data storage device. The paper is composed as follows. Section 2 describes the related work. Section 3 describes the NDAS storage prototype and experimental results. In Section 4, we conclude the paper.

2. Related works

2.1. NAS, SAN, NDAS

Network-Attached Storage (NAS) in Fig. 1(a) is a file-level storage device that is connected to a network and has a CPU and memory. Data can also be shared directly over the network, using file-based protocols such as NFS, SMB, and CIFS. Capacity expansion of NAS is costly because it adds NAS internal interface or adds new NAS device.

Storage Area Networks (SANs) are block-level storage devices that are not directly accessible and require a separate network switch or hub called Fiber Channel. A separately distributed file system or storage management server is required to use and share storage devices in the SAN efficiently. The SAN itself does not provide file abstraction, but file-level access is possible through a file system on the SAN. The number of Fiber Channel switch ports limits the capacity expansion of the SAN.

Fig. 1(b) NDAS is a CPU and memoryless device. DAS or NAS using CPU and memory, and SAN, which requires a separate network environment, are economical because data can be directly input and output using an Ethernet network. NDAS has an Application-Specific Integrated Circuit (ASIC), a SATA controller, and a SATA port. It is a network storage device capable of a block-based data input/output like general storage device.

In addition, it uses the proprietary LPX (Lean Packet eXchange) protocol for data communication without using the TCP/IP protocol. Therefore, there is no overhead due to the network stack because it does not enter the network stack such as TCP/IP at data input/output. At the same time, it is easy to install and expand the capacity because it can be configured on an Ethernet network infinitely through its identifier, which distinguishes each device.

3. Experiment and results

3.1. Experiment environments

In this paper, a prototype system is constructed as shown in Fig. 2 to analyze whether NDAS-based storage system is suitable for big data storage. The 96 NDAS boards are equipped with 78 Seagate 1 TB Barracuda HDDs and 18 Samsung 850 Pro 128 GB SSDs. In this experiment, only HDD was tested except SSD. The host computer used in the experiments consisted of Intel Core i7-6700 CPU and 32 GB memory, and the operating system was CentOS 6.7. Currently, the bandwidth of the computer's network interface card, Ethernet cable, and a switch is 1 Gb/s.

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