Archive Storage Technologies Supporting Information Lifecycle Management

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A large amount of fixed content has been generated due to the ongoing development of the broadband Internet and digital information technology. Moreover, the information contained in e-mails and system logs, and other information must be securely preserved for a certain period, though not yet legally mandated by such legislation as the Sarbanes-Oxley Act and SEC Rule 17a. Consequently, there is a growing need for a special archive storage system that efficiently preserves and manages a large amount of content at low cost. Fujitsu has taken the lead in addressing this need by combining a high-speed disk array device with a low-cost tape library device for the first time, and developed ETERNUS3000 Archive Storage. This paper describes the problems posed by saving fixed content data, and explains the functions and use of ETERNUS3000 Archive Storage that efficiently manages and enables a longer preservation lifecycle for fixed content.

1. Introduction

As an optimum storage infrastructure for the information lifecycle management of huge amounts of fixed content data typified by electronic documents and image data, an archive storage device (ETERNUS3000 Archive Storage) was released worldwide in June 2004.

This product is based on the hierarchical, Write Once Read Many (WORM) recording process dedicated to the storage of fixed content data, and combines a low-cost, high-speed disk array device with a high-capacity, interchangeable library device.

This paper describes the technical features and technology used to ensure the integrity of long-term storage, the assured maintenance of content, and the management software (Content Archive Manager) employed to manage and operate ETERNUS3000 Archive Storage and the entire storage system.

2. Current scenario and problems with content archiving

Given the proliferation of the Internet environment and digitalization of images and video, a lot of content is being created and stored. Moreover, with the easing of regulatory restrictions on e-documents and documents containing personal information (for which only the original documents on such media as paper or film were previously considered valid), digitalized documents are now being accepted as valid. This will lead to a growing volume of digitalized information.

In addition, given recent legislation to protect privacy and prevent unauthorized disclosure of information, e-mail and the access logs of application servers have become the targets of monitoring. At the American Stock Exchange, it is legally mandated to save audit data for a certain term as defined under a strict standard. This information is to be handled as fixed content that must not be modified. Also, the data is not stored

or managed as discrete data, but as structured data through conventional databases. Therefore, there is a growing need to handle such data as fixed content independent of the OS or middleware. Addressing this need requires a new type of archive-dedicated storage that can safely preserve a massive amount of fixed content for long periods at low cost. This is why there is growing demand for a disk array device that can store or reference data at high speed, a tape library that can store massive amounts of data at low cost and for long periods, and a storage solution that can utilize the characteristics of a laser disk library. Under hierarchical storage management (HSM) that employs a disk device and tape library (as used in the R&D market), transparency for applications and low-cost efficient storage are available. However, it is difficult to meet such content-protection requirements as protection against accidental or intentional modification or deletion, and long-term data storage independent of the file system.

Moreover, it is essential to ensure strict security and protection against the manipulation of storage and traceability of access logs for compliance with legislation protecting privacy and preventing the illegal disclosure of information that may be audited by a third party. To ensure protection against such disclosure of information, preserved data must be maintained for a long time, and data for which the maintenance term has expired must be deleted. Although these two requirements may appear conflicting, both must be addressed.

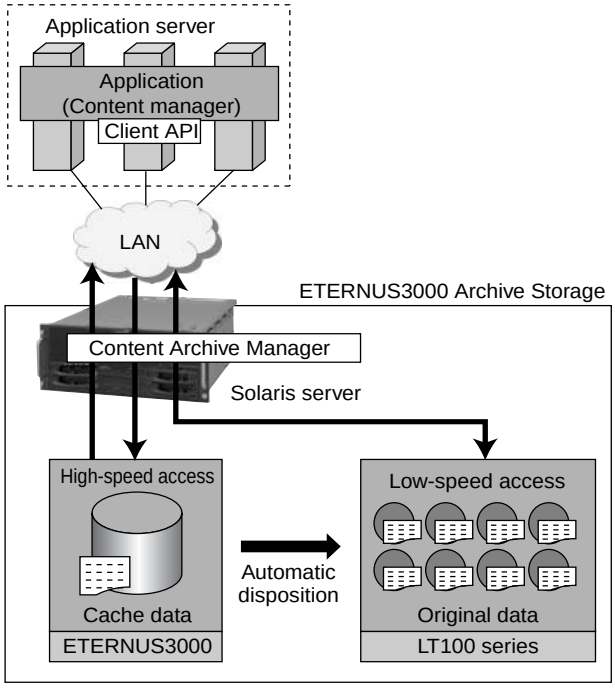
3. Development of archive storage

Given the background described above and to meet the market requirements for suitably managing the lifecycle of maintained data, Fujitsu developed ETERNUS3000 Archive Storage.

The major features are described below.

1) Reduced cost for maintaining data using HSM technology

It is necessary to store massive amounts of digital content for longer periods, at lower cost, and with increased safety and efficiency than that possible by conventional storage. Therefore, to reduce data storage and management costs, HSM was constructed using removable media, such as a low-cost, high-speed disk array device combined with a high-capacity tape library or laser disk. Since these high-speed disk arrays maintain frequently referenced data, high retrieval performance is consequently achieved. Data accessed less frequently is stored on low-cost removable media. Though the data saved on removable media is likely to be offline content, the same protocol applies as for the high-speed access of disk array data, thus leading to transparency (**Figure 1**). Therefore, those applications referencing the data need not consider how the data is stored.



API: Application Programming Interface

Figure 1
Internal structure and overview of ETERNUS3000 Archive Storage.

In addition, the capacity of disk array devices or removable media can be determined based on customer space requirements. Moreover, there is no need for a backup scheduling plan for information already retained, because a copy of the original data is retained automatically and securely on highly reliable and removable media.

Summary of operation:

When data from an application is written and saved to the disk array device, the data is assigned a unique ID. Thus, IDs never to be duplicated are assigned to every batch of retained data.

The ID assigned when data is written is passed on when the data is read. When data corresponding to the passed ID exists on the disk, it is immediately passed to the application in a manner similar to operation on an ordinary disk. When the corresponding data only exists in the tape library, it is first extracted from the tape library, and then passed to the application. As a result, it is possible to read the same data immediately.

As described above, data access using assigned IDs makes the use of data transparent for an application without having to know where a certain file is located, such as a specific disk or directory. This also eliminates the need to manage the capacity of each disk.

2) Data protection using WORM technology

It has become more important to protect against the accidental or intentional deletion of data by applications or users than to protect against such hardware trouble as a crashed disk device. Therefore, the entire storage system of ETERNUS3000 Archive Storage is built based on the WORM structure. WORM stands for "write-once read many" and makes it impossible to alter or delete already written data, much like a CD-R or DVD-R.

By using a dedicated Application Programming Interface (API) technique and Content Archive Manager, ETERNUS3000 Archive Storage can build entire storage systems having the WORM structure to eliminate any possibility of requests from applications or users being intentionally or accidentally altered or deleted.

Moreover, since ETERNUS3000 Archive Storage has no logical capacity limits, it can be considered a type of "DVD-R unlimited storage."

Example of operation:

Assume that file "A" is written with an ID assigned and reported to the application. Then, whenever file "A" is subsequently modified (such as when being written by an application), the data is handled as a different entity. As a result, an ID different from that previously assigned to file "A" is newly assigned and reported to the application. This provides added protection against the intentional or accidental modification or deletion of data.

3) Long-term data maintenance throughout product lifetime using the metabolic feature

Since the hardware media used for storage have a certain lifetime, data cannot be maintained beyond the full data lifecycle span on the same hardware. Moreover, the removable media should be maintained not only for the product lifetime of magnetic tape devices and laser disks, but must also ensure compatibility in the production of generation change depending on a product lifecycle of five or ten years. In addition, the reading out of data must be ensured under any future circumstances. ETERNUS3000 Archive Storage has a "metabolic feature" that can automatically migrate data to new media in the system. All that is required is simply adding next-generation tape or a next-generation laser disk device to automatically migrate the saved data and refresh it on the new media. This metabolic feature executes migration with less impact on applications and system operation. Thus, repeated use of the metabolic feature over a 10-year period makes long-term maintenance possible automatically on the storage side.

Summary of operation:

Storage media generally have a set life span. This life-span value in terms of media is principally based on the access count for read/write

operations or the mount count of media for access. This value is updated and managed at every access. When the set life-span value is reached, data migration is executed automatically. When a new storage device is connected, automatic migration is performed between the old and new storage devices.

Moreover, data on the media can be accessed even during data migration. Thus, migration operation does not affect the access of data being migrated.

4) Standardized data stored by using XML management tags

To maintain data for a long time, the data should be stored as if on paper or etched in stone. In the digital scenario, this means guaranteeing the retrieval of information by storing as much data as possible on systems that are independent of the OS or middleware, such as database software or file systems.

ETERNUS3000 Archive Storage adds management tags in Extensible Markup Language (XML) format to all saved content and creates attribute information for standardizing saved data. As a result, even if there is no relevant system available in the future, the attribute information in XML format can be read from the media by any system, thus making such information reusable. Moreover, only removable media used to save data can ensure recovery in case of a disaster and provide low-cost, long-term data maintenance.

4. Main uses and example of application in the medical field

The features of ETERNUS3000 Archive Storage described above are mainly targeted for use in fields that require the handling of massive amounts of read-only data and long-term data maintenance. Data such as the image data collected by medical equipment in the medical field, digital information on insurance policies in the insurance field, personal information or documents managed by the government and financial firms, and e-mail or logs used for auditing can be applied to this archive storage.

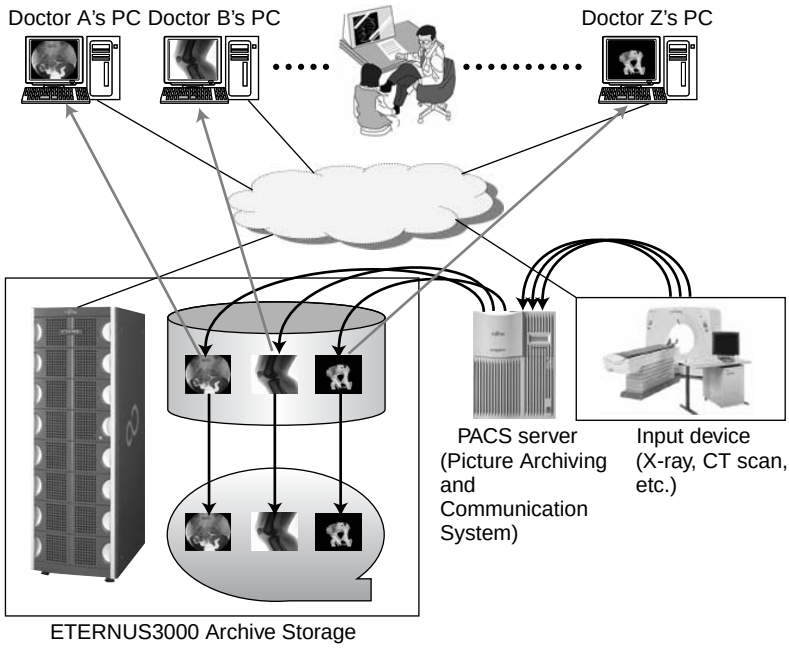


Figure 2
Model of collaboration with HOPE/DrABLE-EX.

The use of archival storage has already been implemented in the medical field.

This archival storage system enables the saving and retrieval of medical image data on patients as requested during examination and diagnosis in collaboration with HOPE/DrABLE-EX, Fujitsu's Picture Archiving and Communication System (PACS) software designed for healthcare systems (**Figure 2**).

Previously, image data had to be written on either CD-R or DVD-R, both of which have very small capacity. Consequently, the number of media required to store massive amounts of image data exceeded the quantity that could be loaded on the system. Thus, relatively old data was stored on media to be maintained outside the system. To reference this data, an external search had to be made outside the device, and then the corresponding media had to be loaded on the system. This process was both tiresome and very annoying.

By introducing ETERNUS3000 Archive Storage, huge amounts of data can be maintained on the device and necessary data immediately referenced as requested. Thus, this system not only improves usability, it also simplifies data management.

5. Conclusion

Fixed content data is expected to expand significantly in areas of application involving huge volumes of data and where legislation for protecting data is required. It is our firm belief that ETERNUS3000 Archive Storage represents a key technology that can meet the growing need for information lifecycle management by handling such information appropriately.

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