White Paper
Evolving All-Flash Arrays
- FUJITSU ETERNUS AF S3 series -

The FUJITSU Storage ETERNUS AF S3 series provides up-to-date functionality on cutting-edge hardware. This model guarantees highly reliable performance base on Fujitsu's history of expertise.

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Preface

Digital transformation is mandatory for businesses today. As a result, storage systems have progressed to solve high-priority issues such as improving the performance and reliability of databases and virtual environments.
As database infrastructures and virtual environment infrastructures become faster and more sophisticated, storage systems are required to deliver high-speed access to match their advancement.

Latin for eternal, "ETERNUS" is the global brand name adopted in 2002 by Fujitsu for their storage systems with a mission to "permanently protect our customer's important assets" and "pursue 24/7 uninterrupted operations". Fujitsu has been offering various storage products as well as related services to accomplish this mission.

Here, Fujitsu presents the ETERNUS AF S3 series All-Flash Arrays for optimized high-speed processing.
The ETERNUS AF S3 series is equipped with cutting-edge hardware by total supplier Fujitsu. By using volumes that can be adapted to individual business needs, this storage system achieves high-speed access performance as well as cost optimization using the data compression function.
In addition to offering new hardware and features, the ETERNUS brand continues to provide optional functions that are just as simple, secure, and reliable as before.

This document provides an overview of the technical features of the ETERNUS AF S3 series All-Flash Arrays.

The product lineup and product information stated in this document are current as of November 2019.

■Applicable Model

This document covers the following model.

- ETERNUS AF S3 series All-Flash Arrays (excluding ETERNUS AF150 S3)

■Naming Conventions

The following abbreviations are used in this document.

- ETERNUS AF250 S3 ..... FUJITSU Storage ETERNUS AF250 S3
- ETERNUS AF650 S3 ..... FUJITSU Storage ETERNUS AF650 S3

1. Movement Toward All-Flash Arrays

Even for large-scale databases, an increasing number of systems execute processes in the memory to increase speed. As a result, storage systems that can load data faster than ever are required. In addition to speeded-up databases, the number of companies adopting large-scale virtual servers as a common base for such systems has increased. Along with virtualization and movement to the cloud for business operations, the usage environment for storage systems has also changed significantly.
When an HDD-based storage system is shared by cloud environments and multiple physical servers, the storage system may become a bottleneck if there are too many access requests from the servers, which causes negative effects on business operations.
In such circumstances, the installation of an all-flash array is one solution that can be considered to solve such problems.

1.1. Requirements for the Information Society

Progress in the IT sector has been swift, including rapid advancements in devices such as smartphones and tablets. Starting with services such as social media, these devices are now being used to create and collect customer data instantaneously. The collected big data must be processed as quickly as possible by means such as artificial intelligence (AI) and machine-learning. The goal for storage systems is to store massive amounts of data and to provide an access performance that can process the stored data.

1.2. Storage for Large-Capacity Memory Servers

In order to increase the processing speed of servers, they are being equipped with a large memory capacity to utilize in-memory databases such as SAP HANA.
Executing processes directly in the memory is the most desirable for high-speed processing. However, HDD-based storage systems are insufficient due to their limited loading capacity. There is now a move toward flash memory, which can load at high speed.

1.3. Fujitsu's All-Flash Arrays

Fujitsu's ETERNUS AF S3 series has the following special characteristics:

- Excels at high-speed processing such as databases.
- Able to install large-capacity devices which are not available in HDD-based storage systems.
- By using the deduplication/compression function, data can be stored even more efficiently.
- A variety of functions are available to link with other products such as OpenStack, VMware, Oracle, and Microsoft, so operations and monitoring can be continued seamlessly.

2. Configuration of the ETERNUS AF S3 series

The ETERNUS AF S3 series is an all-flash array that boasts world class processing capability and scalability. With the latest Intel® Xeon® processors, the ETERNUS AF S3 series provides high performance with a maximum of 900,000 IOPs to achieve fast data access.
The Storage Acceleration Engine is used to execute deduplication/compression processes offloaded from the CPU while retaining high performance. This series is designed for high-speed processing via flash memory and to handle ever increasing data.

FUJITSU Storage ETERNUS AF250 S3

FUJITSU Storage ETERNUS AF650 S3

Table 2-1 Specifications of the ETERNUS AF S3 series

		ETERNUS AF250 S3	ETERNUS AF650 S3
Maximum physical capacity (The physical capacity calculated when 1 TB = 1,000 GB and 1 GB = 1,000 MB)		8,110 TB	32,440 TB
Number of controllers		2	2
System memory capacity		128 GB	1,536 GB
Number of host interface adapters		2 / 4	2 / 4 / 6 / 8
Number of host interface ports	FC (32 Gbit/s)	4 / 8	4 to 32
	FC (16 Gbit/s)	4 to 16	4 to 32
	iSCSI	4 / 8	4 to 16
Number of drive enclosures		0 to 10	0 to 43
Number of drives		2 to 264	2 to 1,056
Drive capacity	Non-self-encrypting	960 GB / 1.92 TB / 3.84 TB / 7.68 TB /15.36 TB / 30.72 TB	
	Self-encrypting (for FIPS-compliant drives)	1.92 TB / 3.84 TB / 7.68 TB	

FIPS: Federal Information Processing Standard

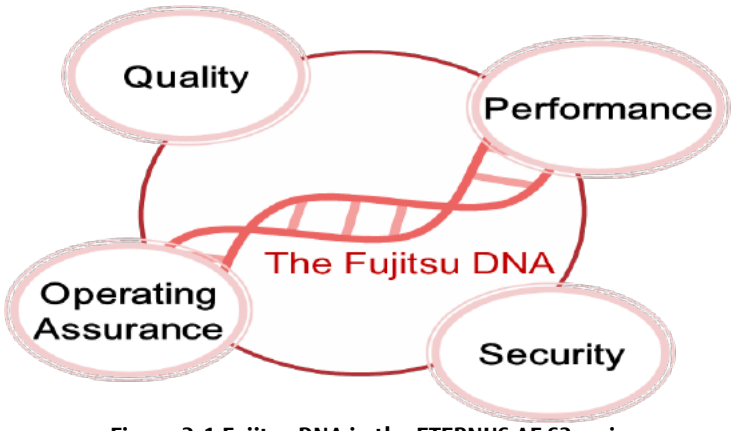

Figure 2-1 Fujitsu DNA in the ETERNUS AF S3 series

The ETERNUS AF S3 series upholds the Fujitsu's four principles of Quality, Performance, Operating Assurance, and Security while offering improved functionality using the Storage Acceleration Engine to implement different types of volumes, such as volumes used for executing high-speed processing and deduplication/compression volumes. The ETERNUS AF S3 series also provides a large number of plug-ins for linking to major operating systems and middleware such as Microsoft, Oracle, and VMware.

3. The Latest Hardware Technology in the ETERNUS AF S3 series

3.1. Enhanced Deduplication/Compression Function for the Storage Acceleration Engine

The ETERNUS AF S3 series is equipped with the Storage Acceleration Engine installed with Fujitsu's original software. Previously, deduplication/compression processes were performed in the CPU. Now, the Storage Acceleration Engine executes processes offloaded from the CPU with a performance two times greater than the existing model.
In the ETERNUS AF S3 series, volumes enabled with deduplication/compression can be used concurrently with volumes that do not slow down high-speed access of the flash memory.
Furthermore, by increasing the size of the controller module (CM) cache, the dedup control table can be further expanded, the capacity of deduplicated volumes can be greatly increased, and data can be stored even more efficiently than before.

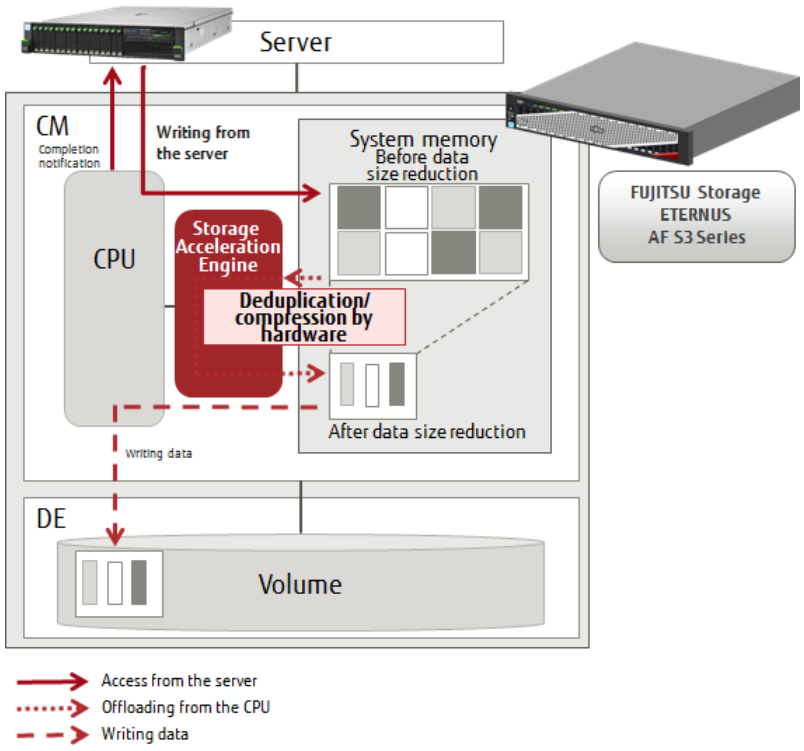

Figure 3-1 CPU Offloading to the Storage Acceleration Engine during Data Compression

3.2. Host Interface for Fast and Flexible Expansion of Business Operations

Due to the expansion of the Channel Adapter (CA), the supported ports that can be expanded for the ETERNUS AF250 S3 is up to 16 ports for 16 Gb FC and eight ports for 10 Gb iSCSI, and for the ETERNUS AF650 S3, up to 32 ports for 32 Gb FC and 16 ports for 10 Gb iSCSI.
Additionally, it is now possible to use different types of interfaces at the same time to create configurations with combinations of both FC and iSCSI.

3.3. No Need To Design the Drive Configuration

The design of the ETERNUS AF S3 series is simple, without the need to configure the capacity of the drives or choose the location for installation.

4. The Value of All-Flash Arrays

The prime reason for choosing an all-flash array is its high-speed access performance. Compared to HDD, flash drives have approximately 1,000 times the access performance. This high-speed access performance is essential when large amounts of data such as in-memory databases are loaded to the memory,

In cases where storing large amounts of data efficiently is more important than having high-speed access performance, the data can be deduplicated and stored in a compressed format to maintain high-speed access while also being able to store data that would otherwise exceed the capacity.

The ETERNUS AF S3 series is an all-flash array that can deliver this function effectively.

4.1. Volumes That Can Be Adapted to Individual Business Needs

In order to efficiently use the drive capacity, the use of Thin Provisioning Pools (TPP) with the ETERNUS AF S3 series is recommended. TPPs can be mixed with two types of volumes; volumes for executing high-speed processing and deduplication/compression volumes for efficient data storage.

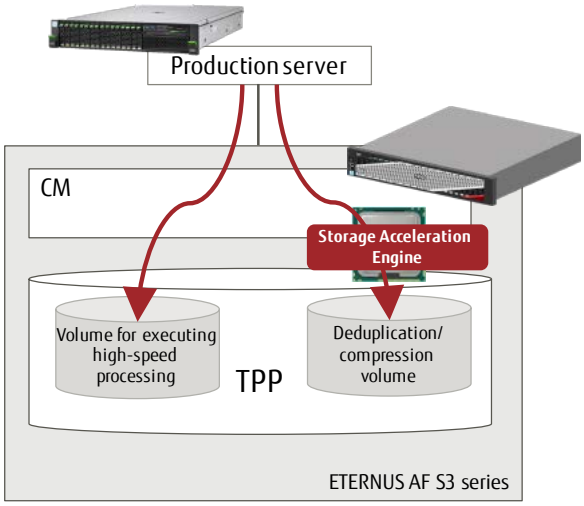

Figure 4-1 Volumes Adapted to Individual Business Needs

4.2. Volumes for Executing High-Speed Processing

By using volumes designed to prioritize high-speed processing, high-speed access is possible when loading and executing processes in the memory such as for in-memory databases, and even for normal databases as well.

Even in large-scale virtual system environments with a concentration of large amounts of access, storage bottleneck can be avoided by using a volume that can execute high-speed processing.

Volumes that can execute high-speed processing are the most important characteristic of all-flash arrays and their greatest appeal.

4.3. Deduplication/Compression Volumes for Efficient Data Storage

The ETERNUS AF S3 series offers deduplication/compression volumes to use large-capacity flash memory more effectively.

The deduplication/compression function, which is enhanced by the Storage Acceleration Engine, can be used to store large amounts of data more efficiently and to achieve superior responsiveness compared to conventional HDD-based storage systems.

The capacity reduction rate varies depending on the type of data.

4.4. Linkage with Veeam Backup & Replication for High-Speed Backups in Virtual Environments

The ETERNUS AF S3 series can be used with FUJITSU Plug-In for Veeam Backup & Replication to link with Veeam Backup & Replication, which specializes in backup operations of virtual environments. With FUJITSU Plug-In for Veeam Backup & Replication, backups of individual virtual machines can be created using storage snapshots.
By taking the lifetime of the VM snapshot created by VMware Storage API[*1] into consideration, conventional backup operations are performed when the load on the production server is low. By leveraging storage snapshots, the VM snapshot lifetime is reduced. This minimizes the impact on the performance of the production server. As a result, designing backup operations can be simplified. FUJITSU Plug-In for Veeam Backup & Replication can be used to create backups without impacting the production server.
Backups can now be created without worrying about the time schedule for execution, and the design for managing backup operations is greatly simplified.

[*1] Formally known as VMware vStorage APIs for Data Protection (VADP)

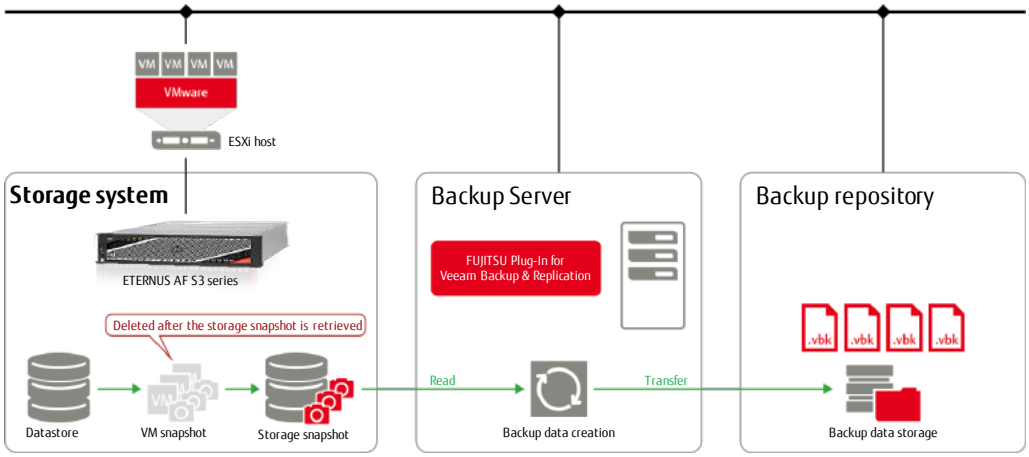

Figure 4-2 Linkage to Veeam Backup & Replication with Veeam Plug-In

5. The ETERNUS AF S3 series: Highly Reliable, High Performing, Secure, Simple

5.1. Quality: Superior Reliability, Availability, and Stability

- **Data Linkage between Storage Systems for Disaster Recovery**
  The ETERNUS AF S3 series supports replication, mirroring, and failover for disaster recovery and can be linked to any storage system in the entire ETERNUS AF/DX series lineup regardless of the generation or model[*1].

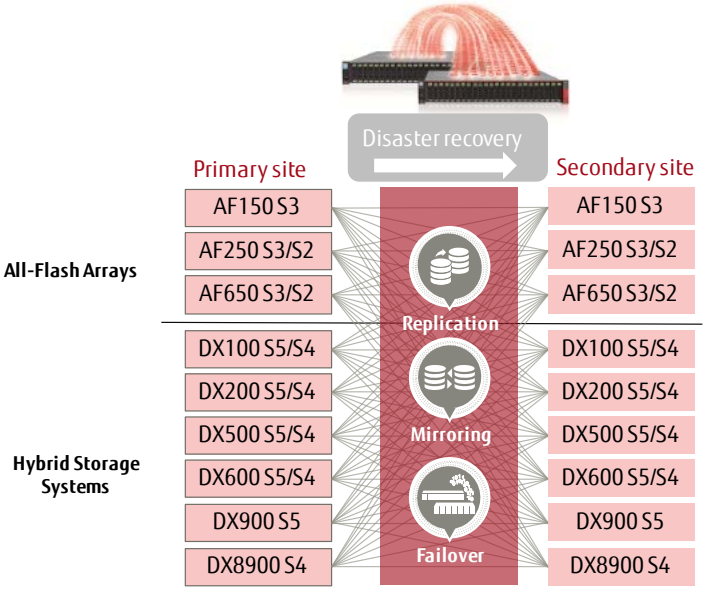

Figure 5-1 Data Linkage between Storage Systems for Disaster Recovery

[*1] There are restrictions on replication, mirroring, and failover for some models.

- **Non-disruptive Storage with ETERNUS SF Storage Cluster**
  The ETERNUS AF S3 series supports ETERNUS SF Storage Cluster, which transparently maintains continuous business operations from the OS even when a problem occurs in the storage system. ETERNUS SF Storage Cluster is a function that is used to retain the equivalence of data between two ETERNUS AF S3 series storage systems, so that even if one of the storage systems becomes inoperable, the function automatically switches to the other storage system for which I/O access is operable, thereby making it possible to continue business operations.
  Additionally, by combining this function with an environment such as VMware HA that can transfer business operations over the server, the availability of the entire system can be improved.
  Test operations for switching or reverting access destinations, imagining a situation in which a problem occurs, can also be performed simply and securely on-screen.
  These operations can be performed on the VMware console via linkage with the vCenter Plug-in.
  4Port CA can now be installed in the ETERNUS AF250 S3 to design clusters more easily.

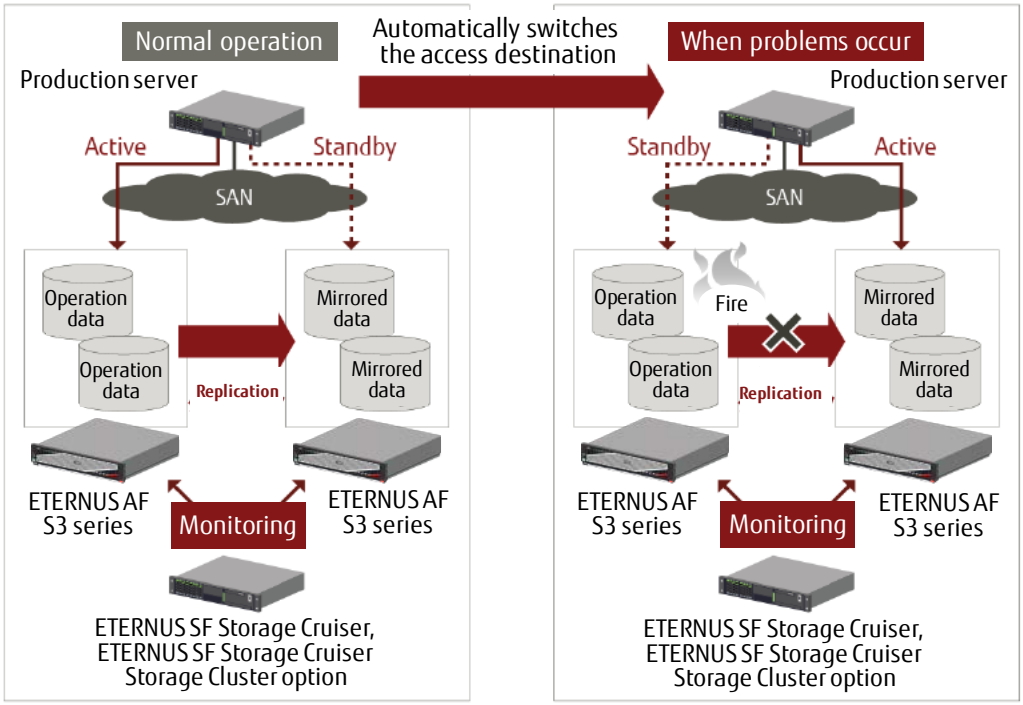

Figure 5-2 Application of ETERNUS SF Storage Cluster

5.2. Performance: Enhanced Stability

- **Improved Stability with Enhanced Simultaneous Processing using Multi-core CPUs**
  With Intel® Xeon® multi-core processors, the amount of I/Os that can be processed simultaneously has been increased.
  Because the load is balanced between all the cores, stable performance is achieved.

- **Reducing CM Load with Flexible Write-Through**
  By writing large amounts of data directly to SSDs, CPU processes are reduced and the maximum performance is improved.

- **Solving Flash Storage Specific Behavior and Reducing Write Latency**
  When data is written to a flash-based storage system, the data is written in unused areas only. Although garbage collection is a background process, if a write is performed to the SSD during a garbage collection, the flash memory performance may be degraded.
  The ETERNUS AF S3 series monitors the garbage collection for individual SSDs to prevent performance degradation. By prioritizing write operations to SSDs where a garbage collection is not in progress, the ETERNUS AF S3 series reduces the write latency to maintain stable responses to write operations.

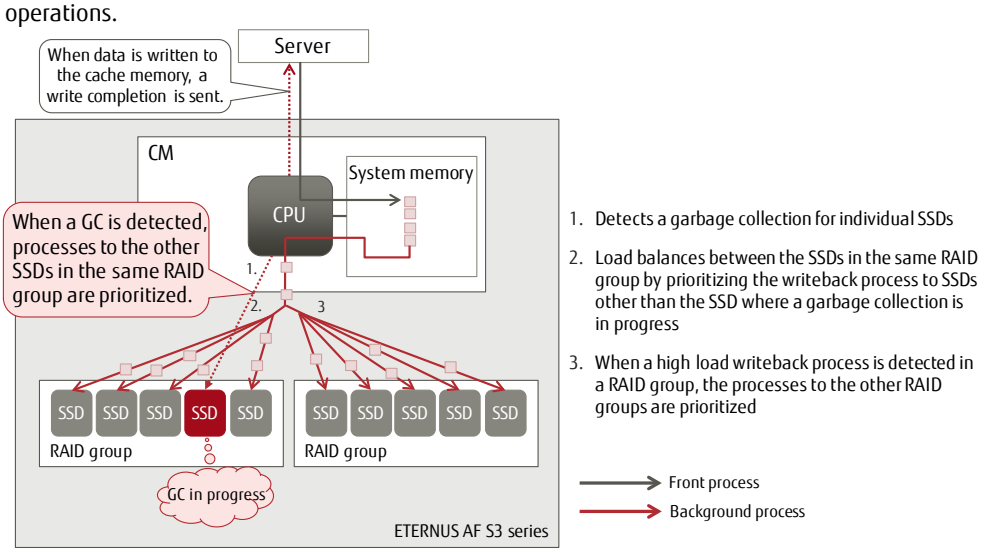

Figure 5-3 Optimized Performance during Garbage Collection

- **Load Balancing for Stable Operation**
  When using a storage integrated environment, if a high load is placed by a single server, there may not be enough resources left to execute other processes, and performance may be severely reduced.
  The Quality of Service (QoS) function is supported to guarantee the processing performance of the prioritized server. By setting an upper-limit on the load for each server, stable server performance can be maintained without being affected by fluctuations in the load on other servers.

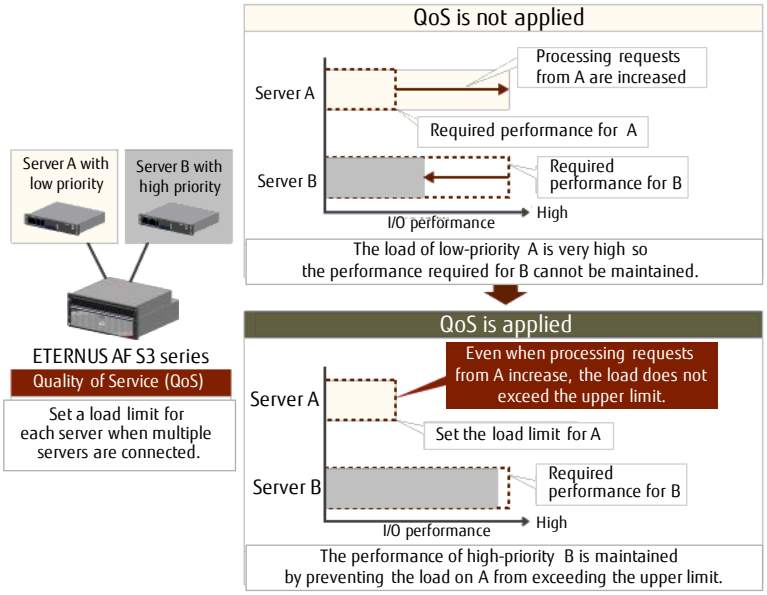

Figure 5-4 Guaranteed Performance with QoS

5.3. Security: Complete Measures

- **Improved Reliability with Check Codes**
  When data is written from the server, this function adds a check code to each block of data and then checks the data integrity at multiple checkpoints during transmission.
  This function enables errors to be detected even in rare cases such as when the data in the storage is destroyed or the data in the drive is corrupted. When data is read from the server, the check codes are confirmed and then removed to ensure that the data consistency of the whole storage system is verified and guaranteed. T10 PI is provided as the standard to guarantee end-to-end data integrity.

- **Secure Communication**
  Normally, data is sent and received across the network without encryption. This leads to the possibility of fraudulent access from Web browsers or CLI by threats who intend to steal, alter, or spoof data during transmissions.
  The ETERNUS AF S3 series supports Secure Socket Layer (SSL) and Secure Shell (SSH) to encrypt information on the network when making transmissions, guaranteeing a high level of security. This function can be used to prevent alteration of data and information leakage.

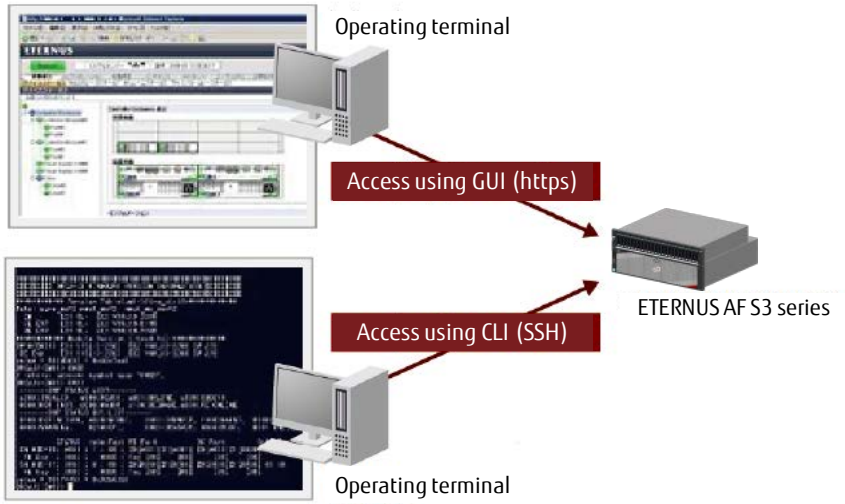

Figure 5-5 Strengthened Security with SSL/SSH

- **Secure Access Controls**
  Since a storage system can be used from multiple servers, business operations handling confidential information and other business operations may access the same storage system. The ETERNUS AF S3 series is provided with a function that sets the volumes accessible from each server and prevents unnecessary access. This function can be used to restrict access from servers without access privileges and guarantee the confidentiality of important data.

- **Secure Data Storage**
  There are two possible methods for encrypting data to prevent information leakage due to misplaced drives. In the first method, the function on the firmware is used to encrypt the data. In the second method, the flash drive itself has a function that encrypts the data when the data is written. Self-encrypting flash drives reduce load on the storage system while maintaining high-speed access.
  FIPS 140-2 compliant self-encrypting drives can be installed starting from the ETERNUS AF S3 series.

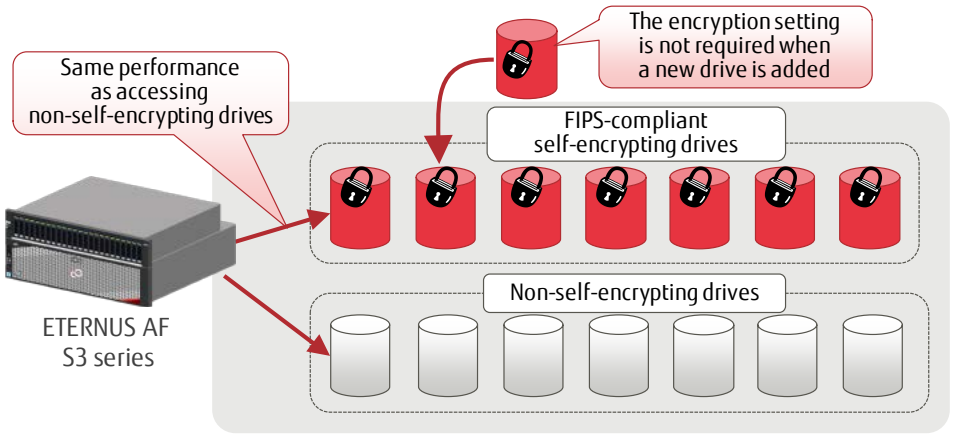

Figure 5-6 Preventing Information Leakage using Data Encryption

- **Retrieval of Audit Logs**
  Audit logs are trail information that record operations that are executed for the ETERNUS AF S3 series and the response from the system. This information is required to judge whether unauthorized access has been made.
  The audit log function enables monitoring of all operations and any unauthorized access that may affect the system.

5.4. Operating Assurance: Accessible and Easy

- **Easy Setup via Smart Setup Wizard**
  The Smart Setup Wizard can be used to set up the ETERNUS AF S3 series simply, quickly, and precisely.
  This feature significantly reduces the amount of time required to configure the settings.

- **Easy Operational Management with FUJITSU Storage ETERNUS SF Storage Software Infrastructure**
  ETERNUS SF can be used to perform operational management, high-speed backups, and disaster recovery for the storage system using GUI operations shared by all models in the ETERNUS AF/DX series, including the ETERNUS AF S3 series.
  ETERNUS SF Storage Cruiser and ETERNUS SF AdvancedCopy Manager, which are the main components of this software infrastructure and the following features are available for all models:
  - A unified graphical user interface (GUI) for all models in the ETERNUS AF/DX series, including the ETERNUS AF S3 series.
  - Reduced costs for operational management with a unified management function and unified update program.
  - Support for a wide variety of platforms (operation is possible in Windows, Linux, and Oracle Solaris environments).
  - Possible to use the functions of all products after inputting the license information.

  ETERNUS SF V16.8 supports the operational management of the ETERNUS AF S3 series.
  In addition to a "Quick Launch" function that is easy to understand and operable, the following functions have been enhanced for improved usability:
  - Improved performance graphs offer enhanced visualization and operability, where the status can be confirmed in real-time.
  - Enhanced snapshot function reduces management cost for backup operation.

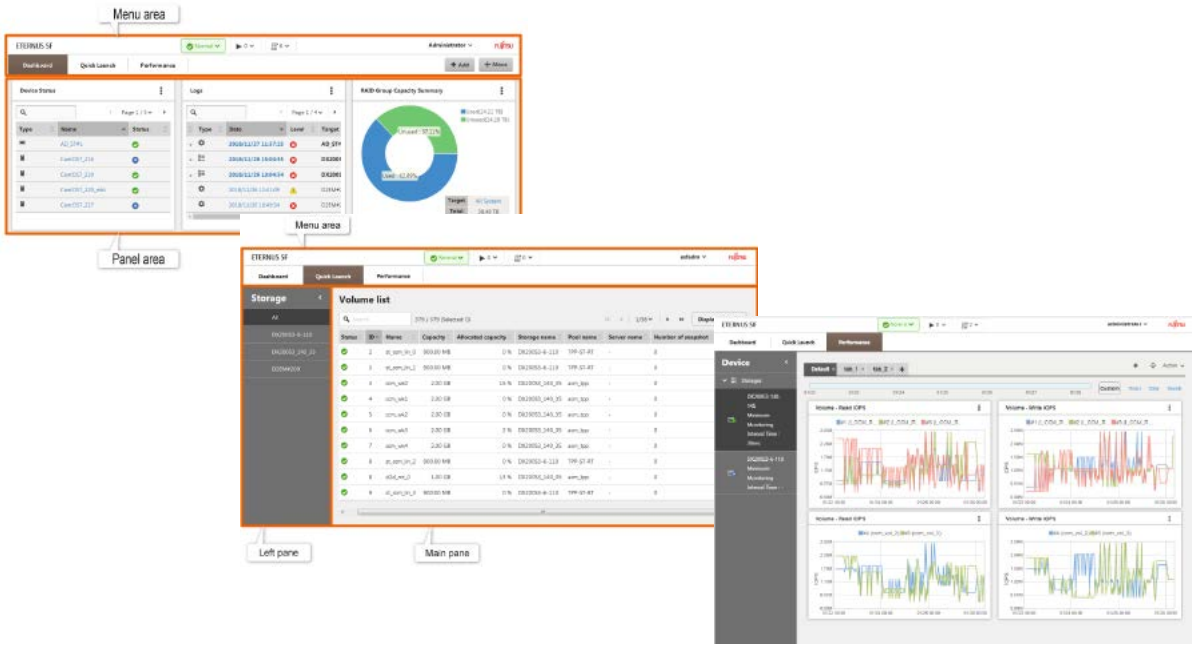

Figure 5-7 FUJITSU Storage ETERNUS SF Storage Software Infrastructure

- **Simple Operation via Linkage with OpenStack**
  ETERNUS OpenStack VolumeDriver is used for linkage with OpenStack. Operations such as creating volumes in the ETERNUS AF S3 series and allocating the created volumes to VM instance can be performed on the OpenStack dashboard (standard interface), which offers the same familiar interface as before.

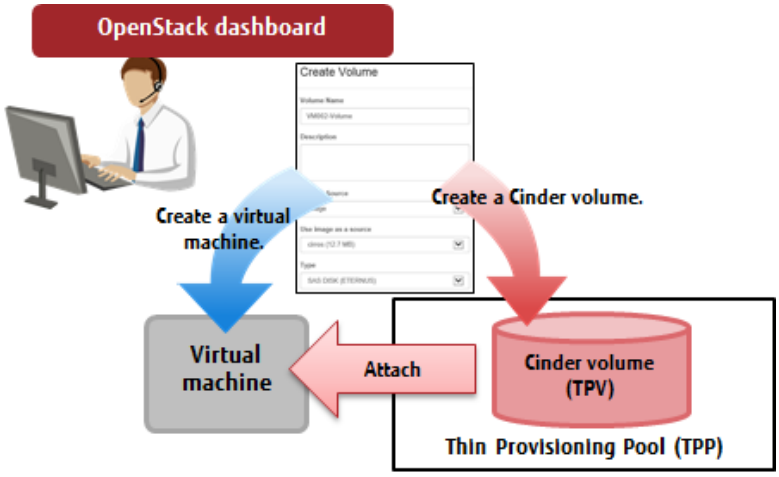

Figure 5-8 Operation of the OpenStack Dashboard

- **Simple Operation Monitoring with VMware**
  There are a multitude of options to link with VMware and a large number of plug-ins are offered. The ETERNUS vCenter Plug-in can be used to expand the user interface of the VMware vSphere Web Client and display a variety of information about the ETERNUS AF S3 series on the VMware vSphere Web Client. The visualization of information on the storage system has been improved, such that information that could previously only be displayed on the ETERNUS Web GUI can now be shown on the VMware vSphere Web Client for improved usability.

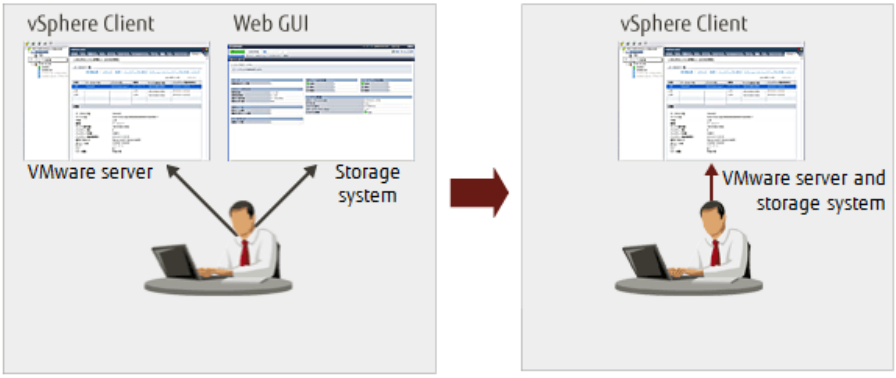

Figure 5-9 Integrated GUI via VMware Linkage

6. Conclusion

Acting as an information infrastructure for in-memory databases and other high-speed processing, the FUJITSU Storage ETERNUS AF S3 series demonstrates optimal data storage performance and reliability that best addresses customer needs.
Volumes used for executing high-speed processing and deduplication/compression volumes for efficient data storage can be used simultaneously.
With the combination of Veeam Backup & Replication and FUJITSU Plug-In for Veeam Backup & Replication, the load due to creating backups can be offloaded from your business to the storage system, for easy backup operations anytime, anywhere.
By providing an optimal balance of Quality, Performance, Operating Assurance, and Security, the FUJITSU Storage ETERNUS AF S3 series maximizes the flash performance to make it the ideal storage system to meet all your needs.

Related Websites

- FUJITSU Storage ETERNUS AF series All-Flash Arrays
  https://www.fujitsu.com/global/products/computing/storage/all-flash-arrays/

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