

論文 / 著書情報  
Article / Book Information

題目(和文)	拡張ファイルメタデータを用いたサーバベースストレージの高機能・高性能化に関する研究
Title(English)	A Study on Applications of Custom File Metadata for High-functional and High-performance Server-based Storage
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Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

(博士課程)  
Doctoral Program

## 論文要旨

THESIS SUMMARY

系・コース： Department of, Graduate major in	情報工学 系 コース	申請学位 (専攻分野)： Academic Degree Requested	博士 Doctor of (工学)
学生氏名： Student's Name	深谷 崇元	指導教員 (主)： Academic Supervisor(main)	横田治夫 教授
		指導教員 (副)： Academic Supervisor(sub)	

要旨 (英文 800 語程度)

Thesis Summary (approx.800 English Words)

In recent years, the demand for large-scale storage systems has been increasing due to the progress of infrastructure system consolidation in the cloud and on-premise environments. To offer large-scale storage at a low cost, server-based storage using commodity servers is increasingly being used as a promising replacement for dedicated storage appliances. Server-based storage aggregates a large number of inexpensive commodity servers over a network and provides redundancy among the servers to achieve scalable and reliable storage. Server-based storage, which offers low-cost large-scale storage, is becoming more widely used in both cloud and enterprise on-premise environments. As server-based storage becomes popular, its target applications are also expanding. Early server-based storage was intended for limited uses such as data analysis and archiving in cloud environments. The early server-based storage introduced simple functionality and workload-specific architecture for limited applications to achieve high scalability. Today, the use of server-based storage has spread to legacy applications such as databases and virtual desktop infrastructure. Legacy applications require high functional coverage of the standard network protocols and high random access performance for storage systems. To meet the demands of these expanding applications, there is a need to improve the functionality and performance of server-based storage.

This doctoral dissertation proposes methods for improving the functionality and performance of server-based storage. All these proposed methods use the custom file metadata, a new metadata framework to offer the extended file metadata capabilities on the commodity operating system (OS) running on server-based storage. This doctoral dissertation proposes three applications of the custom file metadata as shown below.

First, this doctoral dissertation proposes the portable metadata module (PMM) to improve the functionality of server-based storage by using the custom file metadata. PMM is a software module for using the custom file metadata on the commodity OS. PMM allows the protocol stack of the storage appliances to manage the protocol-specific metadata on the commodity OS. PMM uses new user-space metadata management and journal management to achieve the flexibility and reliability of the custom file metadata. PMM enables the protocol stack of the storage appliances to run on the commodity servers, and improves functional coverage of network protocols for server-based storage. I incorporated PMM into the protocol stack of a commercial storage appliance and made the protocol stack runnable on commodity servers. The evaluations confirmed that PMM improves the functional coverage of the network protocol.

Secondly, this doctoral dissertation proposes dynamic redundancy control with adaptive encoding (DRC-AE) to improve the performance of server-based storage by using the custom file metadata. DRC-AE stores metadata of redundancy configuration in the custom file metadata and enables redundancy control of local data across servers. DRC-AE improves the performance of server-based storage by placing an application and its data on the same server. DRC-AE also performs the adaptive encoding, which dynamically changes the data redundancy method according to performance requirements and workloads. DRC-AE uses the adaptive encoding to achieve high capacity efficiency while maintaining high performance. The evaluations confirmed that DRC-AE achieves higher random performance than conventional distributed storage.

Thirdly, this doctoral dissertation proposes dynamic redundancy control with delayed parity update (DRC-DPU) as another performance improvement method using the custom file metadata for server-based storage. DRC-DPU manages differential data for erasure-coded (EC) data by storing metadata of the differential data in the custom file metadata. DRC-DPU asynchronizes slow parity updates by redirecting writes for EC data to replicated differential data. DRC-DPU solves the problem of the degraded write response time of EC data in DRC-AE. The evaluations confirmed that DRC-DPU improves the degradation of the write response time of EC data in DRC-AE.

Finally, this doctoral dissertation discusses the overall effectiveness of the three proposed methods on expanding the target applications of server-based storage. I evaluated the effectiveness of the proposed methods in terms of performance, functionality, and reliability for the major target applications of network storage. I confirmed that the proposed methods dramatically improve the performance of server-based storage in the target applications while meeting the functional and reliability requirements. I also compared the server-based storage with the proposed methods to the conventional storage appliances. The evaluation revealed the performance advantages of server-based storage with the proposed methods and the future challenges in reliability.

The works in this doctoral dissertation contribute directly to designing server-based storage systems that support a wider range of target applications in large-scale infrastructures.

備考：論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。

Note：Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).

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