

Azure NetApp Files: The Premier Cloud-Based File Storage Solution for Enterprise Workloads

Venkata Raman Immidiseti

Sr. Systems Engineer
Raleigh, North Carolina
vimmidiseti@gmail.com

Abstract

In the evolving landscape of cloud storage, organizations seek high-performance, scalable, and secure file storage solutions that integrate with enterprise workloads. Microsoft Azure offers multiple storage services, including Azure NetApp Files (ANF) and Azure Files. This paper presents a comprehensive analysis of Azure NetApp Files, examining its architecture, performance benchmarks, security features, and enterprise integration capabilities. By comparing ANF with Azure Files and Azure Blob Storage, this study highlights ANF's advantages in handling latency-sensitive, high-throughput workloads such as SAP HANA, High-Performance Computing (HPC), AI/ML applications, and large-scale database workloads. The study explores ANF's key attributes, including sub-millisecond latency, dynamic scalability, cross-region replication, data encryption, and support for multi-protocol access (NFSv3, NFSv4.1, and SMB). Unlike Azure Files, optimized for general-purpose workloads, file sharing, and application logs, ANF is tailored for mission-critical applications demanding enterprise-grade performance and data protection. The comparative evaluation illustrates ANF's superior input/output operations per second (IOPS), higher throughput, and advanced management capabilities, making it the preferred choice for businesses requiring low-latency and high-availability storage solutions. This paper assesses ANF's cost-effectiveness, demonstrating how its performance-oriented pricing model benefits organizations needing dynamic resource allocation and optimized storage efficiency. Through an extensive discussion of ANF's real-world applicability, security compliance (HIPAA, GDPR, FedRAMP), and integration with Azure services, this paper establishes Azure NetApp Files as the premier storage solution for enterprises aiming to modernize their IT infrastructure with resilient, cloud-based file storage.

Keywords: Azure NetApp Files, Azure Files, cloud storage, enterprise storage, Network Attached Storage (NAS), high-performance computing (HPC), file storage, scalability, data protection, storage performance, Microsoft Azure, hybrid cloud.

I. INTRODUCTION

The rapid evolution of cloud computing has led to an increased demand for scalable high-performance file storage solutions that can seamlessly integrate with enterprise workloads. Organizations migrating to the cloud require storage solutions that offer flexibility, security, and performance to efficiently support their applications. Microsoft Azure, a leading cloud service provider, offers multiple file storage solutions tailored to diverse business requirements. Azure Files and Azure NetApp Files (ANF) are two key options for file storage. Azure Files are cloud-based file-sharing services that provide managed file shares using Server Message Block (SMB) and Network File System (NFS) protocols. It is designed for general-purpose workloads including file sharing, application logs, and lightweight storage requirements. Conversely, Azure NetApp Files is a fully managed, enterprise-grade network-attached storage (NAS) service designed for

high-performance workloads, offering sub-millisecond latency, advanced data protection, and seamless scalability. Building on NetApp's ONTAP storage technology, ANF integrates directly with Azure, providing a native first-party storage solution within the cloud ecosystem.

As organizations transition their workloads to the cloud, selecting the appropriate storage solution is critical to optimizing performance, reducing costs, and ensuring high availability. This aims to provide a comprehensive analysis of Azure NetApp Files, examining its technical advantages over Azure Files and elucidating its effectiveness in handling mission-critical, performance-intensive workloads. By comparing the features, capabilities, and ideal use cases of both solutions, this paper seeks to assist organizations in making informed decisions regarding their cloud storage strategies.

II. AZURE NETAPP FILES OVERVIEW

Azure NetApp Files (ANF) is a high-performance, fully managed file storage service that natively integrates Microsoft Azure. This service is designed for enterprise-grade applications and workloads that require low latency and high throughput, utilizing NetApp's ONTAP storage technology to provide seamless scalability, data protection, and reliability within Azure's cloud infrastructure. ANF is classified as a first-party Azure service, indicating its direct integration into the Azure portal, command-line interface, and application programming interfaces, thus eliminating the need for third-party software installations or configurations. The service is deployed across Azure regions globally, enabling enterprises to utilize their capabilities across multiple datacenters.

Key architectural components:

- ANF volumes are provisioned within storage pools, where users can select service levels that match their performance requirements.
- Multiple protocols, including NFSv3, NFSv4.1, and SMB 3.1.1, allow flexibility across Linux and Windows environments.
- ANF can be seamlessly integrated with Azure Virtual Machines, Kubernetes, and Azure Backup, among other services.

One of the defining characteristics of ANF is its high-performance capabilities, which are optimized for workloads that require extreme throughput and submillisecond latency. ANF offers:

Three Performance Tiers:

- Designed for general-purpose file workloads.
- Suitable for performance-sensitive applications like VDI profiles.
- Optimized for extreme-performance workloads such as SAP HANA and high-performance computing (HPC).

The storage capacity and performance can be dynamically adjusted without downtime, making it suitable for workloads with fluctuating demands. Supports up to 100 TiB per volume, offering significantly higher scalability than traditional file storage options.

Data Protection and Security

Ensuring data security and business continuity is the key focus of ANF. The service offers multiple security and protection mechanisms.

- Allows enterprises to restrict user access based on defined roles within Azure Active Directory.

- All data are encrypted at rest and in transit, ensuring compliance with industry standards, such as HIPAA, GDPR, and FedRAMP.

Up to 255 snapshots per volume for instant recovery from accidental deletions or system failures. Cross-regional Replication (CRR) for disaster recovery solutions.

Integration with Enterprise Workloads

ANF is purpose-built for demanding enterprise applications and seamlessly integrates with key workloads, including the following:

- It provides high-speed file storage for relational databases that require low-latency disk performance.
- ANF is an Azure-certified storage solution for SAP HANA that ensures compliance with SAP's stringent performance benchmarks.
- Supports thousands of concurrent user sessions in Windows Virtual Desktop environments.
- It enables faster training of AI models by providing high-speed, low-latency file access to the datasets.

High Availability and Reliability

The ANF provides an enterprise-class SLA (99.99%), ensuring high availability and minimal downtime. The key reliability features include the following.

- Ensures continued access to storage during system failures.
- Supports deployment across multiple availability zones for additional fault tolerance.
- With cross-region replication and instant failover capabilities, ANF helps businesses maintain continuity, even in the case of outages.

Cost and Pricing Considerations

While Azure NetApp Files is a premium storage service, its pricing model is based on provisioned capacity and a selected performance tier, ensuring cost-effectiveness for performance-intensive workloads.

- Customers only pay for the storage they provision.
- Costs vary according to the selected service level (Standard, Premium, Ultra), with higher tiers providing a greater throughput.
- Thin provisioning allows optimizing resource allocation.
- Automated tiering enables dynamic cost management based on workload demands.
- Snapshot efficiency minimizes storage consumption.

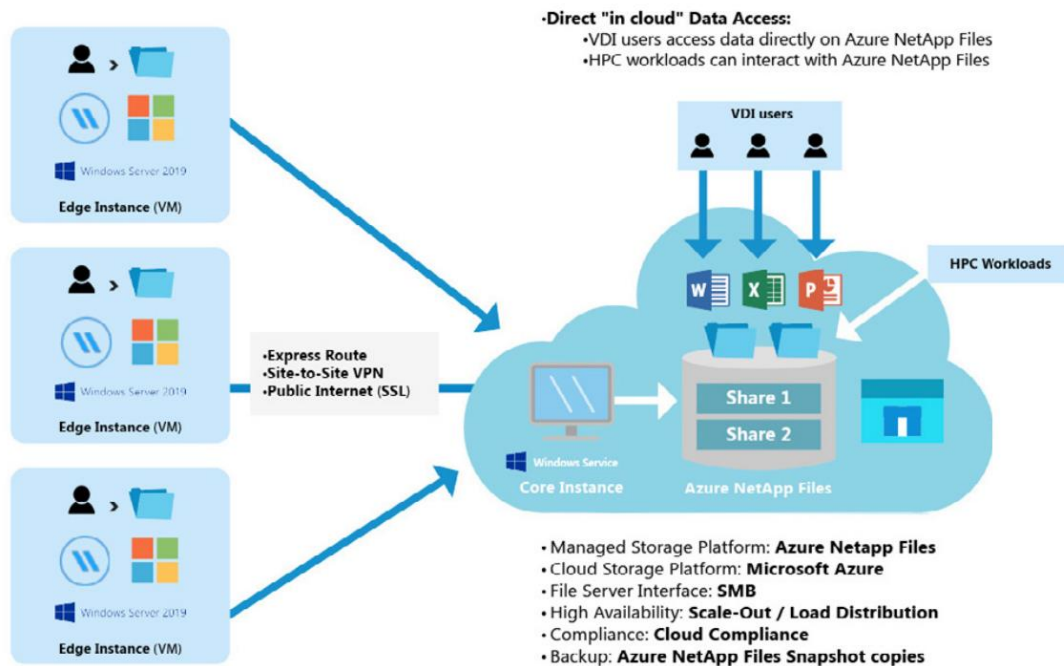


Figure 1: File shares on Azure NetApp files

III. OVERVIEW OF AZURE FILES

Azure Files is a fully managed cloud file-sharing service provided by Microsoft Azure designed to facilitate scalable and secure file storage solutions for organizations of varying sizes. The service enables entities to establish file shares that can be accessed through industry-standard protocols, such as server message blocks (SMB) and network file systems (NFS). These file shares can be seamlessly integrated into existing on-premises infrastructure or cloud-native applications, rendering Azure Files an adaptable solution for diverse organizational use cases.

A significant advantage of Azure Files is its managed nature, which eliminates the complexities associated with deploying and maintaining on-premise file servers. Organizations can utilize Azure Files to create file shares that multiple virtual machines (VMs) and applications can access concurrently, thereby providing a centralized file storage mechanism. The service offers redundancy and high availability, ensuring that the stored data remain resilient to potential failures. This is achieved through replication across the Azure storage infrastructure, which offers durability and fault tolerance.

Azure Files support two performance tiers: standards and premiums. The Standard tier is optimized for workloads that require moderate throughput and lower cost, whereas the premium tier is designed for performance-intensive applications, offering low latency and higher input/output operations per second (IOPS). These performance tiers allow organizations to select a storage configuration that aligns with their workload demands.

A key differentiator of Azure Files is its seamless integration with Azure Active Directory (Azure AD), enabling fine-grained access control through role-based access control (RBAC). This integration ensures secure authentication and authorization, making it suitable for enterprises with stringent security requirements. In addition, data are encrypted both at rest and during transit, enhancing protection against unauthorized access.

Another critical aspect of Azure Files is their compatibility with Azure Backup, allowing organizations to implement automated snapshot-based backups without requiring third-party software. This feature enhances data protection by enabling rapid recovery in the case of accidental deletions or corruption.

Use cases for Azure Files span various industries and applications. The service is widely utilized for file sharing in distributed teams, hosting application configuration files, storing user profiles in Virtual Desktop Infrastructure (VDI) environments, and serving as persistent storage for containerized applications. Azure Files are particularly beneficial for organizations transitioning from traditional on-premises file storage to a hybrid or fully cloud-based storage model because they provide consistent performance and high availability without the need for extensive infrastructure management.

Despite its advantages, Azure Files have limitations, particularly in scenarios that demand ultralow latency, high throughput, or multiprotocol access. Although it supports SMB and NFS, it lacks the comprehensive protocol flexibility and advanced performance optimizations found in Azure NetApp Files. These constraints render Azure Files more suitable for general-purpose workloads than high-performance computing (HPC) or mission-critical enterprise applications.

In conclusion, Azure Files offer a cost-effective, scalable, and secure file storage solution for organizations seeking to modernize their IT infrastructure. Although it may not match the performance benchmarks of Azure NetApp Files, it remains a viable option for businesses seeking managed file storage with high availability, security, and ease of integration within the Azure ecosystem.

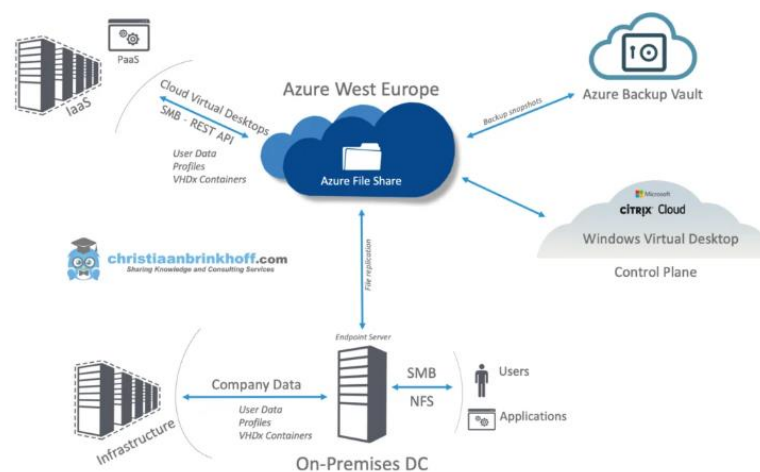


Figure 2: Azure file share access in hybrid cloud

IV. AZURE NETAPP FILES vs AZURE BLOB vs AZURE FILES

A comprehensive analysis of Azure NetApp Files, Azure Files, and Azure Blob Storage provides valuable insights into the strengths and limitations of each service for distinct use cases. Azure Blob Storage is primarily designed for large-scale read-intensive workloads, particularly those that involve sequential access patterns. It is an optimal solution for scenarios where data are ingested once and are infrequently modified, offering an efficient, cost-effective storage model with minimal maintenance requirements. Common applications include large-scale data analytics, backup and archival storage, media rendering, genomic sequencing, and workloads related to autonomous vehicle data processing. Supporting both NFS- and REST-based protocols, Azure Blob Storage delivers significant input/output performance with scalable throughput and is capable of handling large volumes of unstructured data. Its flexible architecture allows for extensive scaling and accommodates vast amounts of data without strict capacity constraints.

Conversely, Azure Files are designed for workloads that require high availability and random-access capabilities. It provides comprehensive support for POSIX-compliant file systems and integrates seamlessly with containerized environments, including the Azure Kubernetes Service (AKS) and Azure Container Instances (ACI), as well as traditional virtual-machine-based workloads. Its primary uses include shared file storage, database storage, home directories, enterprise resource planning (ERP) systems, and content management solutions. Azure Files are particularly beneficial for organizations migrating from on-premise NAS environments that do not require advanced management capabilities. The service supports both SMB and NFS protocols, delivering performance suitable for high-throughput applications with scalability extending to substantial storage volumes per share.

In contrast, Azure NetApp Files are a fully managed cloud-based NAS solution that offers superior management functionalities, making it well suited for enterprise-grade workloads with demanding performance requirements. It is optimized for scenarios that require low-latency, high-speed random access, and robust data-protection mechanisms. This includes on-premise NAS migrations that necessitate advanced management features, mission-critical applications such as SAP HANA, high-performance computing environments with intensive input/output requirements, and applications that demand simultaneous multi-protocol access. Azure NetApp Files provide extensive support for NFS and SMB protocols with options for dual-protocol configurations, making it a versatile solution for hybrid cloud deployment. It delivers industry-leading input/output operations per second (IOPS) and high-throughput capabilities, ensuring consistent performance even under heavy workloads. The service can be scaled dynamically to accommodate substantial storage needs, supporting large file sizes while maintaining high efficiency across distributed cloud environments.

Although all three storage solutions cater to different workloads, Azure Blob Storage remains the most cost-effective option for high-capacity, low-maintenance storage, which is best suited for analytics and archival purposes. Azure Files serve as a flexible, high-availability solution for general-purpose file storage, particularly for applications that require integration with virtualized and containerized platforms. However, for enterprises with stringent performance, security, and data protection requirements, Azure NetApp Files stands out as the premier choice, offering unparalleled scalability, multiprotocol support, and advanced storage management features within the Azure ecosystem.

Category	Azure Blob Storage	Azure Files	Azure NetApp Files
Use cases	<p>Blob Storage is best suited for large scale read-heavy sequential access workloads where data is ingested once and minimally modified further.</p> <p>Blob Storage offers the lowest total cost of ownership, if there is little or no maintenance.</p> <p>Some example scenarios are: Large scale analytical data, throughput sensitive high-performance computing, backup and archive, autonomous driving, media rendering, or genomic sequencing.</p>	<p>Azure Files is a highly available service best suited for random access workloads.</p> <p>For NFS shares, Azure Files provides full POSIX file system support and can easily be used from container platforms like Azure Container Instance (ACI) and Azure Kubernetes Service (AKS) with the built-in CSI driver, in addition to VM-based platforms.</p> <p>Some example scenarios are: Shared files, databases, home directories, traditional applications, ERP, CMS, NAS migrations that don't require advanced management, and custom applications requiring scale-out file storage.</p>	<p>Fully managed file service in the cloud, powered by NetApp, with advanced management capabilities.</p> <p>Azure NetApp Files is suited for workloads that require random access and provides broad protocol support and data protection capabilities.</p> <p>Some example scenarios are: On-premises enterprise NAS migration that requires rich management capabilities, latency sensitive workloads like SAP HANA, latency-sensitive or IOPS intensive high performance compute, or workloads that require simultaneous multi-protocol access.</p>
Available protocols	<p>NFSv3</p> <p>REST</p> <p>Data Lake Storage</p>	<p>SMB</p> <p>NFSv4.1</p> <p>(No interoperability between either protocol)</p>	<p>NFSv3 and NFSv4.1</p> <p>SMB</p> <p>Dual protocol (SMB and NFSv3, SMB and NFSv4.1)</p>
Key features	<p>Integrated with HPC cache for low latency workloads.</p> <p>Integrated management, including lifecycle, immutable blobs, data failover, and metadata index.</p>	<p>Zonally redundant for high availability.</p> <p>Consistent single-digit millisecond latency.</p> <p>Predictable performance and cost that scales with capacity.</p>	<p>Extremely low latency (as low as sub-ms).</p> <p>Rich ONTAP management capabilities such as snapshots, backup, cross-region replication, and cross-zone replication.</p> <p>Consistent hybrid cloud experience.</p>
Performance (Per volume)	<p>Up to 20,000 IOPS, up to 15 GiB/s throughput.</p>	<p>Up to 100,000 IOPS, up to 10 GiB/s throughput.</p>	<p>Up to 460,000 IOPS, up to 4.5 GiB/s throughput per regular volume, up to 10 GiB/s throughput per large volume.</p>
Scale	<p>Up to 5 PiB for a single volume.</p> <p>Up to 190.7 TiB for a single blob.</p>	<p>Up to 100 TiB for a single file share.</p> <p>Up to 4 TiB for a single file.</p>	<p>Up to 100 TiB for a single regular volume, up to 2 PiB for a large volume.</p> <p>Up to 16 TiB for a single file.</p>

Table 1: comparison of azure blob vs azure files vs azure NetApp files

V. CONCLUSION

The shift toward cloud-based enterprise storage solutions requires a robust, high-performance, and scalable file storage service that ensures business continuity, security, and integration with the existing IT ecosystems. This study shows that Azure NetApp Files (ANF) is a superior option for enterprises needing low-latency, high-throughput, and mission-critical storage solutions. Compared to Azure Files and Azure Blob Storage, ANF excels in multiprotocol access, dynamic performance scaling, disaster recovery, and advanced security features, making it optimal for workloads such as SAP HANA, HPC, AI/ML applications, and large-scale databases. ANF provides sub-millisecond latency and a higher throughput than Azure Files, suiting applications with strict IOPS requirements. Its integration with NetApp ONTAP technology enhances the storage efficiency, snapshot management, and disaster recovery, ensuring minimal downtime and operational resilience. The ANF's capacity to support enterprise workloads with enhanced data protection, encryption, and compliance with global security standards (HIPAA, GDPR, and FedRAMP) underscores its viability in highly regulated industries. While Azure Files are viable for general-purpose file storage, they lack performance optimization, multi-protocol support, and advanced security features for enterprise workloads that require high-speed data access. Azure Blob Storage, optimized for large-scale archival and sequential data access, is less suitable for low-latency, high-speed file access needs. Although ANF is a premium service, its benefits outweigh the costs for enterprises that prioritize performance, security, and availability. The ability to scale resources dynamically, allocate storage based on real-time demands, and leverage automated tiering for cost efficiency makes ANF a future-proof investment for cloud-centric organizations. As businesses modernize IT infrastructure, selecting an appropriate storage solution is crucial for optimizing efficiency and maintaining a competitive advantage. Azure NetApp Files delivers unparalleled performance, flexibility, and security for complex enterprise workloads, establishing it as a definitive cloud-based file storage solution for organizations seeking a resilient, high-speed, and scalable storage architecture.

REFERENCES

- [1] Weisz, Michael. "Evaluation of Netapp Cloud ONTAP and Altavault Using Amazon Web Services". CERN, September 2, 2015.
- [2] Venkatesh, Pruthvi Raj. "Integrated Geo Cloud Solution for Seismic Data Processing." INFORMATION TECHNOLOGY IN INDUSTRY 9, no. 2 (2021): 589-604. <https://doi.org/10.17762/itii.v9i2.392>
- [3] Sabale, Arun, and Balu N. Ilag. Microsoft Azure Virtual Desktop Guide. 2022. <https://doi.org/10.1007/978-1-4842-8063-8>
- [4] Bögelsack, A., Chakraborty, U., Kumar, D., Rank, J., Tischbierek, J., Wolz, E. (2022). SAP S/4 on Microsoft Azure – Deployment. In: SAP S/4HANA Systems in Hyperscaler Clouds. Apress, Berkeley, CA. https://doi.org/10.1007/978-1-4842-8158-1_7
- [5] Darr, S. (2022). Plan an Azure Virtual Desktop Architecture. In: Azure Virtual Desktop Specialist. Apress, Berkeley, CA. https://doi.org/10.1007/978-1-4842-7987-8_2
- [6] Udayakumar, P. (2022). Planning and Preparing for AVD. In: Design and Deploy Microsoft Azure Virtual Desktop. Apress, Berkeley, CA. https://doi.org/10.1007/978-1-4842-7796-6_2
- [7] Stefanovic, V., Katinski, M. (2021). Azure Storage. In: Pro Azure Administration and Automation. Apress, Berkeley, CA. https://doi.org/10.1007/978-1-4842-7325-8_6
- [8] <https://f.hubspotusercontent20.net/hubfs/525875/NA-580-0521-Architecture-Doc-R3.pdf>
- [9] <https://karami.au/understanding-azure-files-and-azure-netapp-files/>