

Optimize Siemens Teamcenter with Amazon FSx for NetApp ONTAP

Optimizing Product Lifecycle Management (PLM) workloads on Amazon Web Services (AWS)

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Introduction

Siemens Teamcenter provides a comprehensive Product Lifecycle Management (PLM) platform that enables seamless collaboration among stakeholders throughout a product's entire lifecycle – from design to manufacturing. Teamcenter helps maintain accurate product data, improve design quality, and foster collaboration across diverse internal teams as well as the broader supply chain. Siemens Teamcenter also offers deep integration capabilities with Computer-Aided Design, Manufacturing, and Engineering (CAD, CAM, and CAE) tools, as well as Enterprise Resource Planning (ERP) and Manufacturing Execution Systems (MES). This integration helps companies streamline their entire design and manufacturing processes for a wide range of products, from automobiles and aircrafts to semiconductors.

Amazon FSx for NetApp ONTAP is a storage service that combines the widely-adopted enterprise-grade features of NetApp ONTAP with the agility, scalability, and simplicity of a fully managed AWS service. Its features include integrated data protection with space-efficient snapshots, native replication between file systems with NetApp SnapMirror, automatic storage tiering to lower-cost storage, storage efficiency features such as compression and deduplication, and highly durable and automated incremental offline backups. FSx for ONTAP allows you to change your file system's throughput, IOPS, and storage on the fly, allowing you to cost-optimize for your workload's demands. Using FSx for ONTAP as your storage backend for Siemens Teamcenter makes it even easier to modernize your organization's PLM infrastructure in the cloud with key values such as increasing engineers' productivity, optimizing costs, enabling efficient collaboration, and ensuring business continuity.

Scope

This document is intended for use by individuals who are responsible for architecting, designing, managing, and supporting Siemens PLM Teamcenter fully hosted and operating within AWS cloud using an Infrastructure-as-a-Service (IaaS) model. It gives the reader an understanding of the value of deploying Teamcenter on AWS with FSx for ONTAP for workflows running exclusively in the AWS cloud.

This document does not cover hybrid architecture or cloud burst scenarios for Teamcenter deployments.

For general information around FSx for ONTAP visit [here](#).

FSx for ONTAP and Siemens Teamcenter Integration

FSx for ONTAP offers a comprehensive solution capable of serving both CAD volumes and databases within the resource tier of Siemens Teamcenter's architecture. This dual functionality ensures seamless data management and storage optimization, critical for the complex workflows of Product Lifecycle Management (PLM) systems.

The considerable size and complexity of CAD files require advanced, high-performance storage solutions. While FSx for ONTAP's ability to support databases is integral to the overall architecture, this document will focus on the value FSx for ONTAP brings to storage for CAD Files. The emphasis is on demonstrating how FSx for ONTAP increases engineers' productivity, optimizes infrastructure costs, facilitates collaboration, and ensures business continuity.

This document aims to highlight the specific benefits and technical considerations of leveraging FSx for ONTAP while detailing the alignment with the AWS Well-Architected Framework, particularly in terms of operational excellence, security, reliability, performance efficiency, cost optimization, and sustainability, ensuring a robust and efficient CAD data management strategy in the cloud.

Architecture Overview of Siemens Teamcenter

The Siemens PLM Teamcenter platform employs a four-tier software architecture consisting of clients, webservers, business logic servers, search server, file management system, volumes, and database. This architecture is highly scalable, enabling organizations to configure and deploy application services across multiple servers allowing for load balancing and workload distribution across different systems to support numerous users.

Client Tier: The client layer of the architecture consists of two main components, a Java-based Rich Application Client (RAC) and an ActiveWorkspace (Web-Browser Client). These client interfaces directly interact with applications like computer-aided design (CAD) and visualization tools installed on the end-user's workstation. Both the RAC and the Web-Browser Client communicate with the web tier using the HTTP (or HTTPS) protocol. These clients are designed to function seamlessly across various network environments, including local area networks (LANs) and wide area networks (WANs), ensuring a consistent user experience regardless of the underlying network infrastructure.

Web Tier: The web tier acts as an intermediary between the client tier and the enterprise tier. It consists of an ActiveWorkspace gateway and web servers. It handles client requests by directing them to the suitable enterprise tier servers for processing, and then returns the results back to the clients.

Enterprise Tier: The enterprise tier is where the core business logic processes execute. It receives requests from the web tier and processes them by making the necessary data requests to the systems in the resource tier.

Resource Tier: The resource layer comprises a relational database that holds the metadata associated with various products. It also includes file storage volumes that contain various types of files like Computer-Aided Design (CAD) files, Portable Document Format (PDF) files, and lightweight visualization files etc... Additionally, this tier incorporates a Solr search server to facilitate search functionality in Active Workspace client.

The File Management System (FMS) is an overarching system that governs the file management in Teamcenter, handling the storage and transfer of files between the primary volume servers, local server caches, and client caches. It has two components:

- FMS server cache (FSC) is the FMS server cache server process. The FSC is a shared, secure, server level cache. It uploads and downloads files to other FSCs and to FCCs.
- FMS client cache (FCC) is the FMS client cache server process. The FCC runs within the Teamcenter client communication (TCCS) module. The FCC provides a private user-level cache, just as web browsers provide a read file cache. The FCC provides a high-performance cache for both downloaded and uploaded files. The FCC provides proxy interfaces to client programs and connectivity to the server caches and volumes.

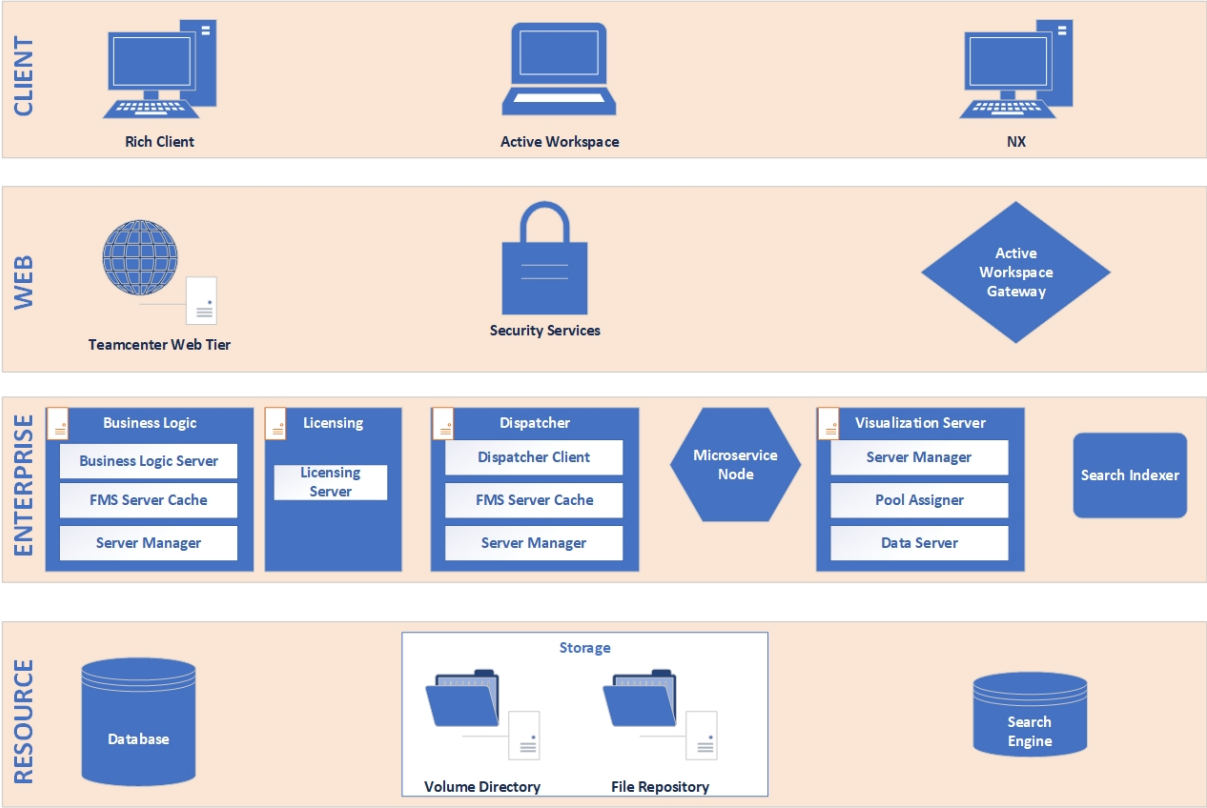


Figure 1) Siemens architecture

Teamcenter Architecture on AWS

Deploying Teamcenter on AWS provides customers with more flexibility and lower cost of ownership compared to an on-premises deployment. Teamcenter services can be installed on Amazon EC2 instances in a single or multiple server configuration based on customer and infrastructure needs. Some of the benefits of running Teamcenter on AWS are,

- With Teamcenter deployed on AWS, organizations can avoid the upfront capital expenditure associated with on-premises infrastructure and only pay for the computing, storage, and other resources required for their specific usage. This pay-as-you-go model can lead to significant cost savings, especially for organizations with fluctuating workloads which allows them to scale up or down based on demand.
- AWS's multiple Availability Zones within a region provide high availability and data replication, enabling Teamcenter to continue operating even in the event of a data center failure.
- AWS's managed services such as Amazon Relational Database Service for Oracle (RDS) and FSx for ONTAP offload the management and maintenance of databases and file systems, allowing Teamcenter administrators to focus on core application management.
- Teamcenter data, including product designs, bills of materials, and other sensitive information, can be encrypted at rest and in transit using AWS services, ensuring data confidentiality and integrity.

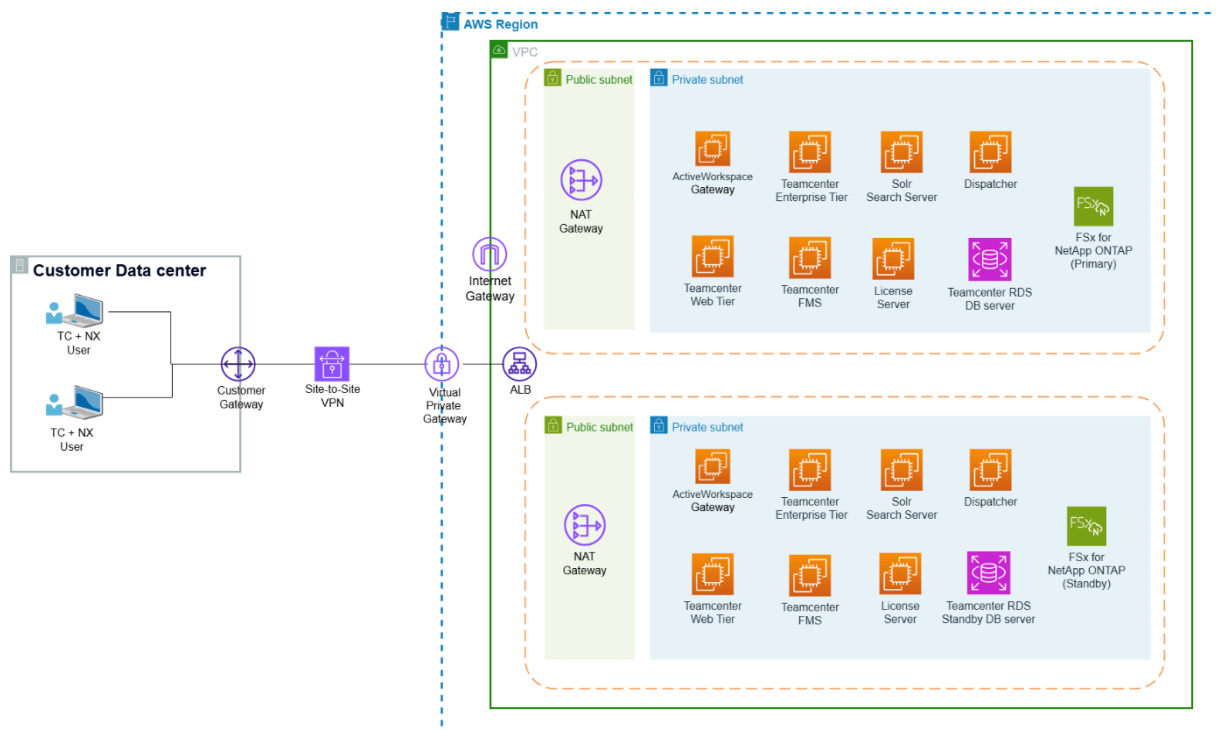


Figure 2) Siemens architecture on AWS

Amazon FSx for NetApp ONTAP for Siemens Teamcenter

In product development environments, there is a common set of key challenges. Customers deploying Siemens PLM Teamcenter will often operate in a distributed development environment and thus there is a need to have data available 24/7. It is also crucial to control costs, minimize data loss, accelerate recovery, and meet PLM performance requirements. FSx for ONTAP enables product development organizations to access data across multiple geographic locations within AWS's secure and scalable ecosystem by providing the Teamcenter application access to shared datasets with consistent performance and low latency. Key features also include storage efficiencies, intelligent replication, cost-effective disaster recovery options, and data mobility.

The key values of FSx for ONTAP for Siemens Teamcenter environments in AWS include:

- **Increase engineers' productivity:** Speed up data retrieval for engineers and shorten time-to-market with high performance capabilities
- **Optimize Costs:** Reduce cost using data tiering, thin cloning, and storage efficiency technology
- **Enable efficient collaboration:** Maximize team collaboration with multiprotocol access and advanced data sharing capabilities
- **Ensure business continuity:** Meet your RPO and RTO with application-aware snapshots, disaster recovery and backup

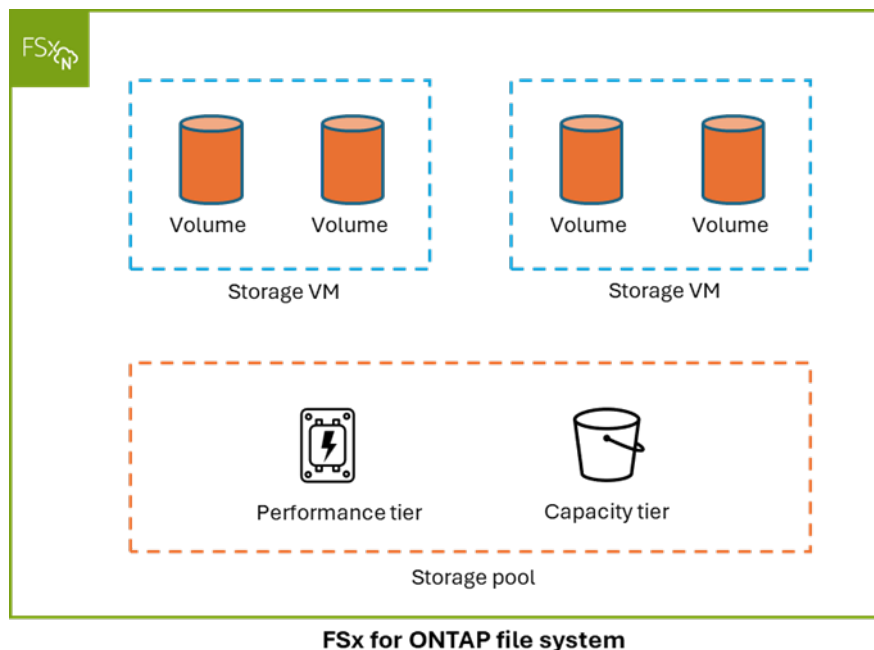


Figure 3) FSx for ONTAP file system architecture

AWS Well Architected Framework

Operational Excellence

Project requirements can rapidly change, and new projects can increase data and storage requirements. With on-premises file systems, you'd typically need to maintain healthy storage and performance headroom in order to accommodate rapidly changing requirements, and plan for new capacity weeks in advance should project requirements exceed the capabilities of your current storage infrastructure. FSx for ONTAP allows you to quickly and non-disruptively react to new or changing project requirements.

Cloning

NetApp FlexClone® technology enables instant, space-efficient clones of production or test data to be created easily, minimizing storage requirements. With NetApp FlexClone, each engineer can have his or her own virtual copy of production or test data for use in test and development activities.

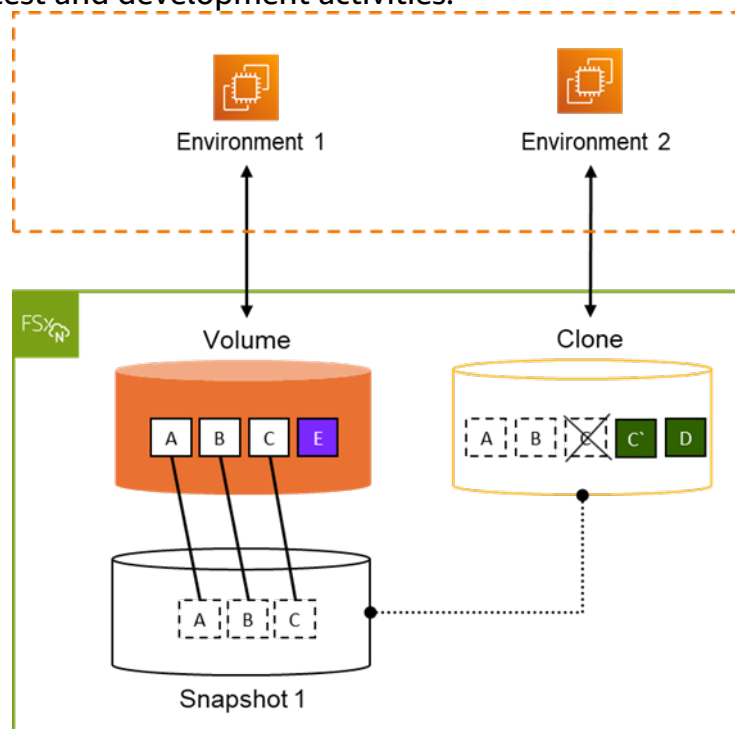


Figure 4) FSx for ONTAP cloning

Snapshots

Point in time backups are useful for quickly recovering data in the event of data loss or corruption. Traditionally, customers rely on unconventional save options and revision manipulation to manage point in time backup and recovery for Teamcenter workloads. Managing this process can have unexpected side effects and the process itself can disrupt data access for up to hours at a time. Such lengthy disruptions can significantly affect the product development process.

NetApp Snapshots™ are an easy-to-use solution for point in time backups. They are enabled by default on your FSx for ONTAP volumes using the default snapshot policy. Snapshots offer file and folder level granularity which can be used to restore specific Teamcenter data to a previous version to undo changes or recover deleted content.

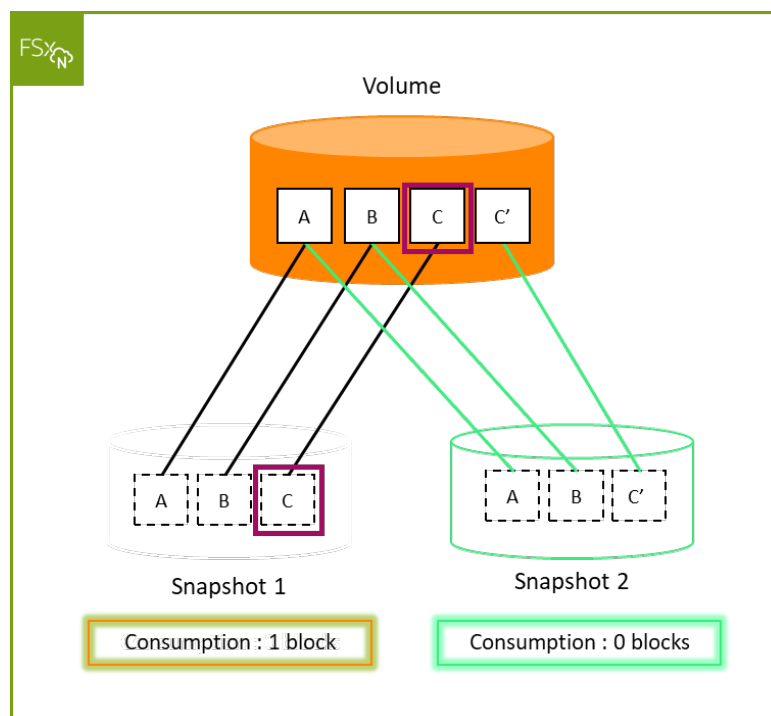


Figure 5) FSx for ONTAP snapshots

Multi-Protocol

FSx for ONTAP natively supports both file and block protocols, including NFS, SMB, and iSCSI, allowing simultaneous native access to your file system from virtually any client for a variety of use-cases, and eliminating the need to replicate data to different storage systems just for protocol-specific access or to deploy non-native protocol packages to your clients. NetApp is the only vendor in the industry to offer unified file and block storage at scale. With unified storage across a broad range of controllers and storage types, a single integrated NetApp cluster can effectively support storage infrastructure for Teamcenter, allowing you to simplify storage management and reduce operating overhead.

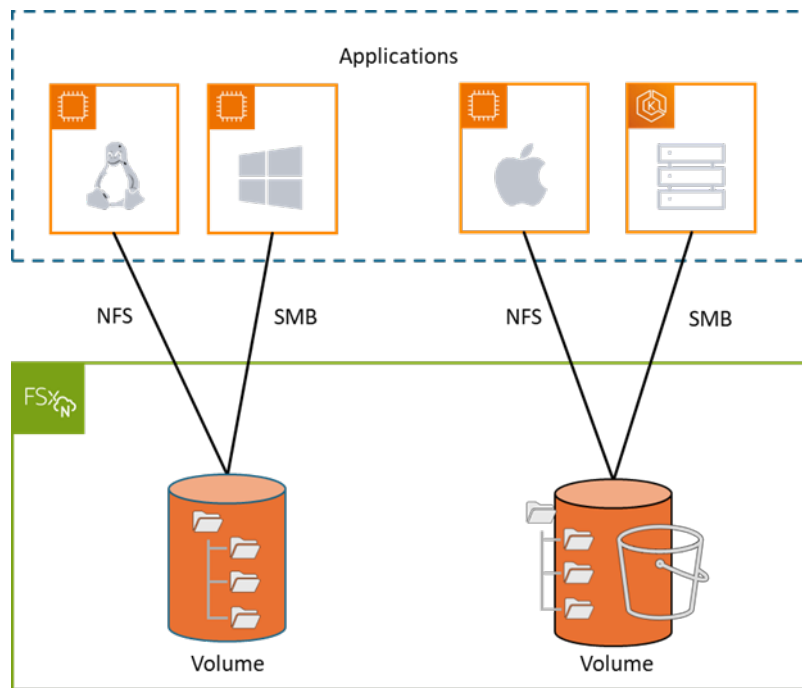


Figure 6) FSx for ONTAP multiprotocol access

Security

Ensuring the security of your Siemens Teamcenter deployment is crucial, particularly when it comes to protecting the product data that lies at the heart of your innovation. FSx ONTAP offers essential security features and capabilities when serving as the storage solution for your Teamcenter implementation. By leveraging these security measures, you can establish a secure and robust foundation for your product lifecycle management processes, ensuring the confidentiality, integrity, and availability of your critical data.

Managed Protection

FSx for ONTAP provides built-in encryption for data at rest and in transit. Data at rest is automatically encrypted using keys managed by AWS KMS, while data in transit is encrypted before leaving AWS facilities. FSx for ONTAP also supports IPsec and Kerberos-based encryption for various storage protocols, adding an extra layer of security and flexibility.

As a fully-managed service, FSx for ONTAP regularly performs maintenance and updates, including security patches, with minimal impact on most workloads.

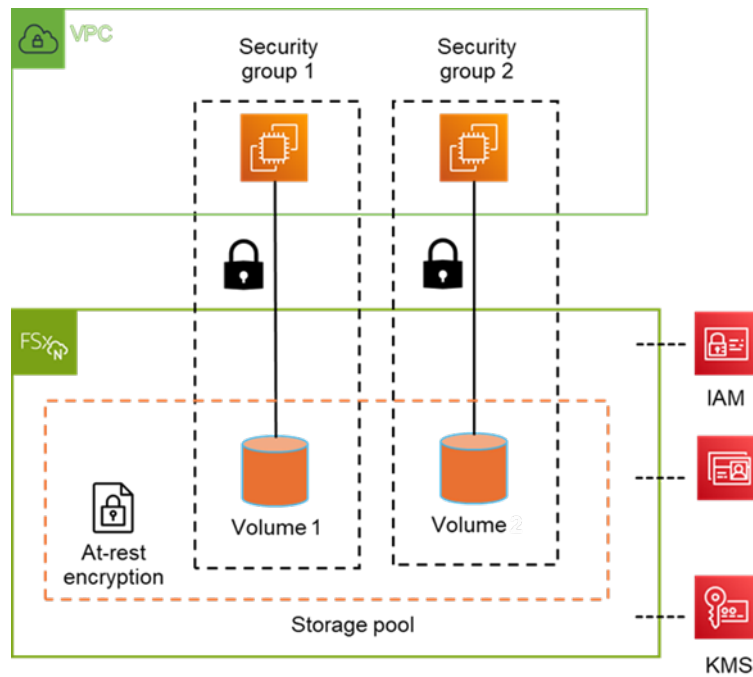


Figure 7) FSx for ONTAP security group model

Multi-Layered Security

To access your FSx for ONTAP file systems and storage virtual machines (SVMs), Teamcenter uses the DNS name or IP address when configuring the file vaults. The DNS name corresponds to the private IP address of the file system's or SVM's elastic network interface within your VPC. For Teamcenter to access the data in the file vaults, the application needs to reside within the associated VPC, or be connected to the VPC via AWS Direct Connect, PrivateLink or VPN.

Within your VPC, you can configure security groups to act as virtual firewalls for your Teamcenter file vaults. These security groups provide granular control over inbound and outbound traffic between your Teamcenter components, as well as between Teamcenter and other applications, allowing you to define precise access rules and maintain a secure environment.

Administrative and file access auditing

FSx for ONTAP supports file access auditing, enabling you to record end-user accesses to individual files and directories within a storage virtual machine (SVM) based on defined audit policies. You can use audit event logs generated to reduce the risk of unauthorized access, and implement least-privileged best practice on your Teamcenter data.

To further enhance traceability and auditability, you can use AWS CloudTrail to capture all API calls for Amazon FSx as events, providing a record of actions taken by users, roles, or AWS services. By capturing and analyzing events from logs and metrics, you gain increased visibility into your system and can take prompt action on security events and potential threats, ultimately strengthening the security of your Teamcenter implementation.

Reliability

Teamcenter PLM must effectively manage varying workloads and swiftly recover from disruptions to ensure uninterrupted service. Handling complex product lifecycles often involves dealing with substantial file sizes and executing long-running processes. FSx for ONTAP supports these business continuity requirements by enabling low Recovery Point Objectives (RPOs), ensuring minimal data loss and rapid recovery capabilities that are crucial for maintaining operations during disruptions.

Backups

The disruptions associated with backups are so significant that backups might be done infrequently. Unfortunately, such an approach puts more of your users' work at risk. FSx for ONTAP backups use NetApp Snapshot technology, which provides automatic, incremental, crash-consistent daily backups that are stored across multiple Availability Zones for durability. These are best suited for archival, data retention, and compliance use cases. You can also protect FSx for ONTAP volumes by using AWS Backup, which allows you to configure scheduled and on-demand backups of your volumes and restore them as new FSx for ONTAP volumes. This allows you to manage FSx for ONTAP backups alongside your other AWS workloads.

Disaster Recovery (DR)

With traditional storage infrastructures, the complexity of the environment and the available data mirroring solutions make disaster recovery (DR) solutions difficult or impractical to implement. NetApp SnapMirror® technology makes DR practical by replicating data to another FSx for ONTAP system, including across AWS regions. SnapMirror provides very low Recovery Point Objectives (RPOs, as low as 5 minutes) and Recovery Time Objectives (RTO in single-digit minutes). Implementing DR significantly reduces risks for your organization and protects your data in case of a catastrophic event.

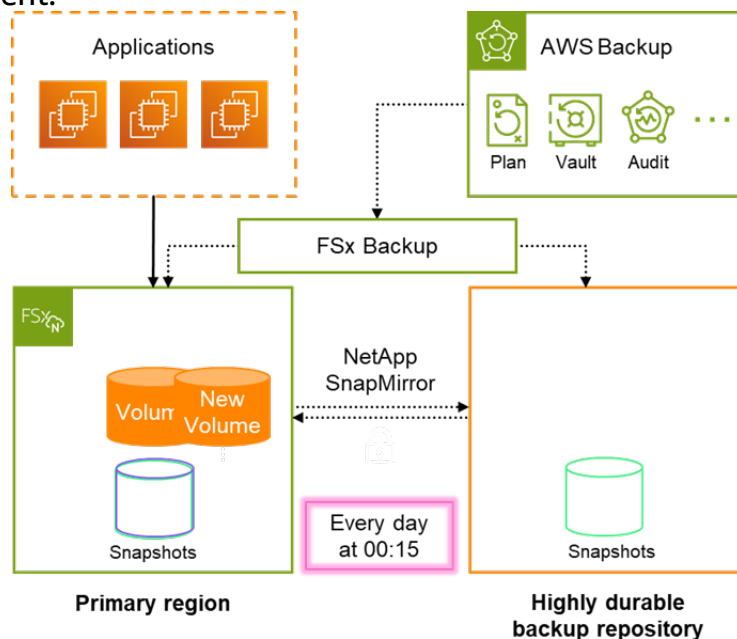


Figure 8) FSx for ONTAP data protection methods

Performance Efficiency

Architecting high-performing workloads ensures that workloads use infrastructure resources efficiently to meet requirements and maintain effectiveness as demand changes and technologies evolve. As a fully managed shared storage solution, FSx for ONTAP brings efficiency and architectural flexibility to Siemens Teamcenter, enabling customers to increase application efficiency, and focus on innovating their products using Teamcenter.

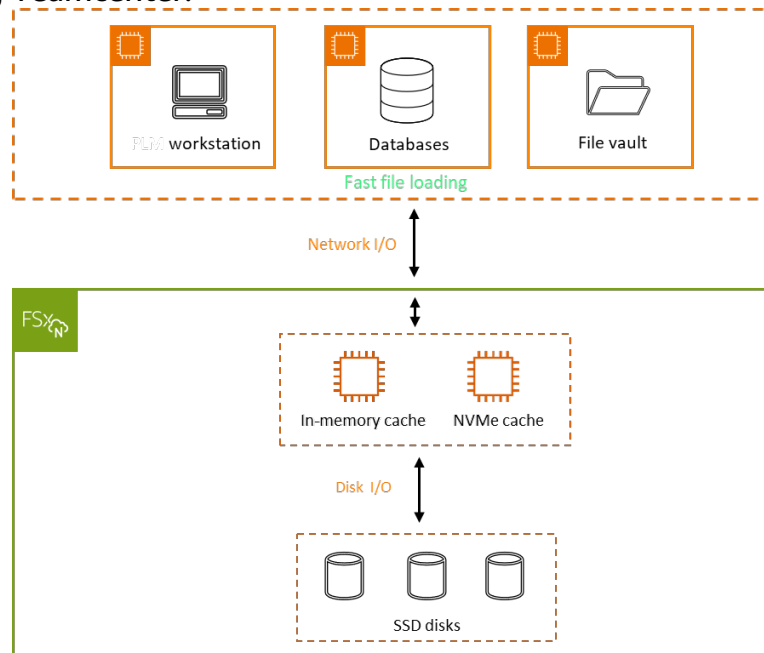


Figure 9) FSx for ONTAP performance

Tiered and Low-latency data storage

FSx for ONTAP provides two storage tiers to optimize performance and cost:

- SSD tier: User-provisioned, high-performance solid-state drive (SSD) storage purpose-built for the active portion of your data set.
- Capacity pool tier: Fully elastic storage that automatically scales to petabytes in size and is cost-optimized for infrequently accessed data.

This tiered storage architecture allows you to store frequently accessed data on high-performance SSDs for sub-millisecond file operation latencies, while moving infrequently accessed data to the cost-optimized capacity pool tier, delivering performant storage for data-intensive PLM applications such as Siemens Teamcenter while balancing costs. Additionally, it features two layers of read caching on file servers with —NVMe and in-memory— to deliver even lower latencies where needed.

FSx for ONTAP also provides up to tens of GB/s of throughput and millions of IOPS, meeting the performance requirements of PLM at most sizes, supporting both random and sequential traffic patterns.

When sizing your SSD tier, consider that it is best suited for providing fast response to large active datasets requiring high throughput and/or IOPS. When provisioning file volumes for your Teamcenter file vaults, determine the percentage of total files currently being worked on by your PLM users, and size the SSD tier accordingly. By covering the read-write traffic on active files in your Teamcenter application with the SSD tier, your users will experience faster file opening, lower retrieval latency, and overall higher productivity.

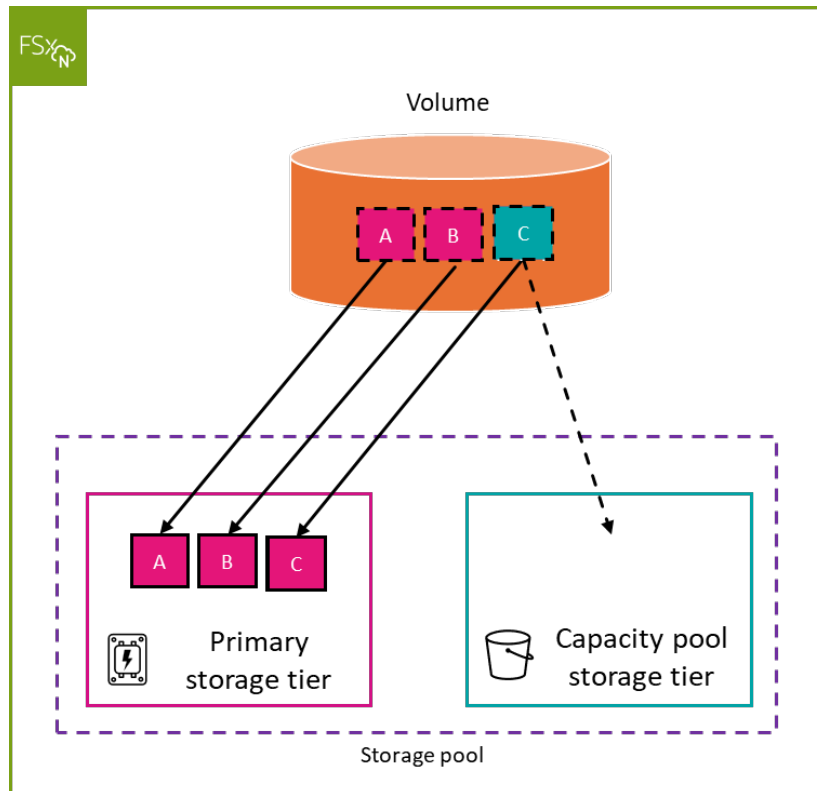


Figure 10) FSx for ONTAP storage tiers

Thin Provisioning and Seamless Scalability

As your Teamcenter user base grows, so do your storage requirements. FSx for ONTAP offers seamless scalability and thin provisioning for your storage volumes, allowing you to allocate the appropriate amount of storage that fits the needs of your Teamcenter workload at any given stage.

In addition to scaling SSD storage capacity, FSx for ONTAP allows seamless scaling of SSD IOPS and file system throughput capacity while remaining available. This allows you to improve your Teamcenter file vaults' IOPS, when needed, without interrupting the end user.

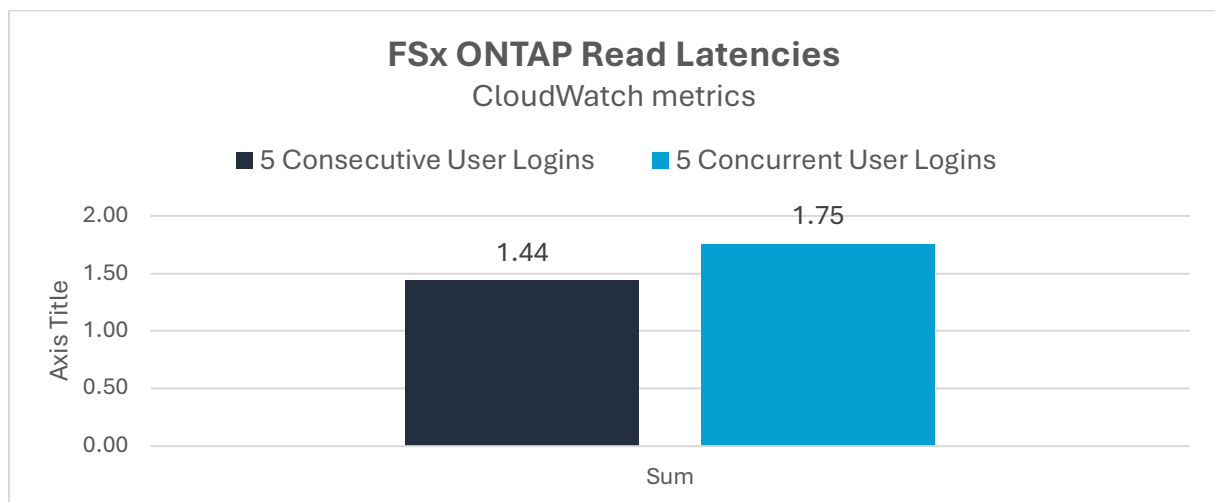
Multi-Protocol Data Access

FSx for ONTAP provides versatile shared storage that can be accessed simultaneously from multiple Linux, Windows, or macOS clients using the NFS (v3, v4, v4.1, v4.2) and SMB protocols. This multi-protocol support makes FSx for ONTAP an ideal solution for the dynamic scale and high-performance file storage needs of Siemens Teamcenter file volumes. Additionally, FSx for ONTAP supports iSCSI protocol access, offering block storage capabilities.

Continuous Performance Improvement

FSx for ONTAP offers a comprehensive set of monitoring tools that enable you to continuously optimize your Teamcenter file vaults' performance. By default, every FSx for ONTAP file system emits file system and volume storage and performance metrics, so you can see the file vault's resource utilization in near-real time, and be informed if you are reaching limits with a recommendation to scale e.g. SSD storage, SSD IOPS, or file system throughput. FSx for ONTAP also offers ONTAP's Event Management System for ONTAP system event monitoring. You also have the flexibility to use NetApp monitoring tools with your FSx for ONTAP file systems, such as NetApp Cloud Insights and NetApp Harvest with Grafana. With the tools available, you are enabled to provide consistent low-latency experience to your Teamcenter users.

Context: Performance Benchmarking for Launching Teamcenter when loading a 413 Megabytes (4,800 BOM Lines) assembly in NX.



Using metrics from CloudWatch, during both consecutive and concurrent user logins to Siemens Teamcenter then loading a CAD Assembly, FSx ONTAP maintained under 2ms average read latency.

Cost Optimization

Fast-growing product development organizations often find that as the amount of PLM data increases over time, operating expenses similarly increase. FSx for ONTAP minimizes administrative activities and costs associated with growing infrastructures.

Data Tiering and Storage Efficiencies

FSx for ONTAP has a variety of features that allow you to reduce your Teamcenter workload's physical footprint and cost-optimize as your workload grows over time. From the moment your files first land on FSx for ONTAP, inline compression and deduplication work to reduce the physical storage consumption of your data. Teamcenter deployments using ONTAP filesystems for CAD vault have shown storage efficiencies savings between 38-50%. Compression and deduplication run against new and existing data, continuously reducing storage consumption

wherever possible. Teamcenter data that is less frequently accessed can be transparently moved to FSx for ONTAP's lower-cost capacity pool storage tier, providing automatic cost optimization without affecting developer access. Compression and deduplication savings are maintained as data is tiered to capacity pool storage.

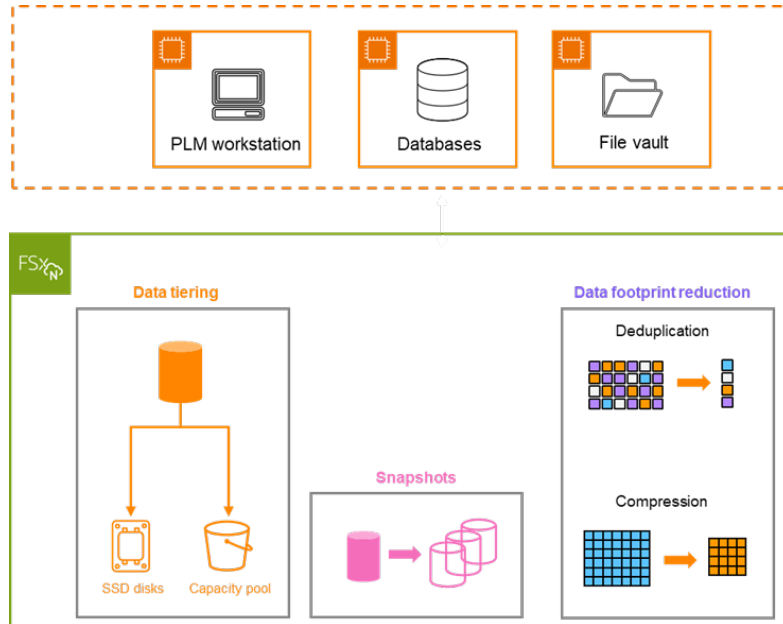


Figure 11) Teamcenter cost optimization with FSx for ONTAP

Sustainability

Achieving efficient product lifecycle management with Siemens Teamcenter is crucial for your organization's success, but it's equally important to consider the long-term environmental, economic, and societal impact of your workloads. Hosting your Teamcenter workload on Amazon Web Services (AWS) and leveraging FSx for ONTAP can more easily help you achieve well-architected goals in sustainability. FSx for ONTAP provides shared file systems for Teamcenter file vaults, eliminating unnecessary data duplication and reducing the total storage requirements, contributing to a more sustainable storage infrastructure. Furthermore, by hosting your Teamcenter workload in AWS regions powered by renewable energy, you ensure that your entire Teamcenter implementation operates on clean energy, significantly reducing your overall carbon footprint. Moving workloads to AWS can lower a customer's carbon footprint by nearly 80% compared to enterprise data centers, and up to 96% when AWS is powered by 100% renewable energy, contributing to ESG (Environmental Social and Governance) goals. AWS provides carbon emission reports to help you understand and minimize the environmental impact of your Teamcenter workload.

Additionally, leveraging FSx for ONTAP for Teamcenter file vaults and database storage also brings the following sustainability advantages:

Sustainable Physical Storage Utilization

FSx for ONTAP optimizes physical storage consumption by intelligently tiering data between solid-state drives (SSDs) and capacity pools. As SSDs are more energy-intensive than magnetic drives, FSx for ONTAP ensures that only the most active and performance-sensitive data resides on SSDs, reducing overall energy consumption while maintaining optimal performance for Teamcenter workloads.

FSx for ONTAP's Thin Provisioning feature dynamically allocates storage capacity as needed, eliminating the need for pre-allocating large amounts of unused storage. This approach minimizes the storage footprint and associated energy consumption.

FSx for ONTAP also employs advanced optimization techniques, such as compression, deduplication, and Snapshots to further reduce the physical storage consumption for Teamcenter data. Compression removes redundant information, deduplication eliminates duplicate data copies, and Snapshots consume physical capacity only for changed file portions. These techniques help Teamcenter application reduces its storage usage and, consequently, their carbon footprint.

Shared Sustainability Impact

FSx for ONTAP, as a fully managed storage solution, takes care of patches and infrastructure upgrades on behalf of its users. Instead of waiting for hardware refresh cycles, the underlying storage infrastructure is continuously updated with newer, more energy-efficient hardware. The service also ensures that software patches that can help reduce energy consumption are applied to your storage system with minimal service interruption, keeping your Teamcenter workload running smoothly and energy-efficiently.

By using managed services like FSx for ONTAP, you can maximize resource utilization and share the sustainability impact of your Teamcenter workload across all tenants of the service. This approach reduces your individual contribution to the overall carbon footprint while still benefiting from the latest energy-saving technologies and practices implemented by FSx for ONTAP.

Best Practices

Selecting the right storage for Teamcenter data to address the needs and requirements of a particular Teamcenter deployment is a complex task. The sizing policies are application specific and vary according to the capacity requirements and workload of every project. However, here are some questions to ask potential joint AWS and Teamcenter customers to assist in sizing the project and understanding the customer's needs and requirements.

- What are their main storage criteria: performance, data protection, reliability, manageability, and so on. If performance is the main criterion, ask them to define their expected latency.
- If they have an existing Teamcenter database and file vaults, what are the current sizes and their expected rate of growth?
- How many product developers will access the Teamcenter database and file vaults?

- What is their existing infrastructure: platform (servers and storage devices), protocol, and network infrastructure details.
- Is storage to be used solely for Teamcenter applications?
- What is their current backup and restore mechanism?

Conclusion

AWS continues to offer compelling solutions for Teamcenter customers with its next generation cloud infrastructure. FSx for ONTAP provides scalable storage infrastructure that helps accelerate product development, improve data protection, and minimize costs for Teamcenter cloud infrastructure.

Contributors

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