DELL Technologies

Specification Sheet

Dell PowerEdge R660

Provides performance and versatility as needed to address your most demanding applications

The new Dell PowerEdge R660 is a 1U, two-socket rack server. Gain the performance you need with this full-featured enterprise server, designed to optimize even the most demanding workloads like dense database analytics and high-density virtualization.

Max Performance

- Add up to two 4th Generation Intel® Xeon® Scalable or Intel® Xeon® Max processors with up to 56 cores or two 5th Generation Intel Xeon Scalable processors up to 64 cores for faster and more accurate processing performance.
- Accelerate in-memory workloads with up to 32 DDR5 RDIMMS up to 4800 MT/sec for 1DPC when using 4th Gen Intel Xeon Scalable processors or 32 DDR5 RDIMMs up to 5600 MT/sec for 1 DPC when using 5th Gen Intel Xeon Scalable processors.
- Support for GPUs including 3 x single-wide for workloads requiring acceleration.

Air cooled at peak performance

- New Smart Flow chassis optimizes airflow to support the highest core count CPUs in an air-cooled environment within the current IT infrastructure.
- Support for up to 8 x 2.5” drives and 2 x 350 watt processors.

Gain agility

- Achieve maximum efficiency with multiple chassis designs that tailor to your desired workloads and business objectives.
- Storage options include up to 8 x 2.5” NVMe/SAS4/SATA, plus up to 10 x 2.5” NVMe/SAS4/SATA, 14/16 x NVME E3.S Gen5.
- Multiple Gen4 and Gen5 riser configurations (up to 3 x PCIe slots) with interchangeable components that seamlessly integrate to address customer needs over time.

Cyber Resilient Architecture for Zero Trust IT environment & operations

Security is integrated into every phase of the PowerEdge lifecycle, including protected supply chain and factory-to-site integrity assurance. Silicon-based root of trust anchors end-to-end boot resilience while Multi-Factor Authentication (MFA) and role-based access controls ensure trusted operations.

Increase efficiency and accelerate operations with an autonomous infrastructure

The Dell OpenManage™ systems management portfolio delivers a secure, efficient, and comprehensive solution for PowerEdge servers. Simplify, automate and centralize one-to-many management with the OpenManage Enterprise console and iDRAC.

Sustainability

From recycled materials in our products and packaging, to thoughtful, innovative options for energy efficiency, the PowerEdge portfolio is designed to make, deliver, and recycle products to help reduce the carbon footprint and lower your operation costs. We even make it easy to retire legacy systems responsibly with Dell Technologies Services.

Rest easier with Dell Technologies Services

Maximize your PowerEdge Servers with comprehensive services ranging from Consulting, to ProDeploy and ProSupport suites, Data Migration and more – available across 170 locations and backed by our 60K+ employees and partners.

PowerEdge R660

The Dell PowerEdge R660 offers powerful performance in a purpose-built, cyber resilient, mainstream server. Ideal for:

- High Density Virtualization
- Dense Database Analytics
- Mixed Workload Standardization

Feature	Technical Specifications
Processor	Up to two 4th Generation Intel Xeon Scalable or Intel Xeon Max processors, with up to 56 cores and optional Intel® QuickAssist Technology. Up to two 5th Generation Intel Xeon Scalable processors with up to 64 cores.
Memory	• 32 DDR5 DIMM slots, supports RDIMM 8 TB max, speeds up to 4800 MT/s • Speeds up to 4800 MT/s on the 4th Generation Intel Xeon Scalable or Intel Xeon Max processors • Speeds up to 5600 MT/s on the 5th Generation Intel Xeon Scalable processors • Supports registered ECC DDR5 DIMMs only
Storage controllers	• Internal Controllers (RAID): PERC H965i, PERC H755, PERC H755N, PERC H355i • External Controller: PERC H965e • Internal Boot: Boot Optimized Storage Subsystem (BOSS-N1): HWRAID 2 x M.2 NVMe SSD drives, or USB • SAS HBAs (non-RAID): HBA355e,HBA355i, HBA465i • Software RAID: S160
Drive Bays	Front bays: • Up to 10 x 2.5-inch, SAS/SATA/NVMe (HDD/SSD) max 153.6 TB • Up to 8 x 2.5-inch, SAS/SATA/NVMe, (HDD/SSD) max 122.88 TB • Up to 14 x EDSFF E3.S Gen5 NVMe (SSD) max 179.2 TB • Up to 16 x EDSFF E3.S Gen5 NVMe (SSD) max 204.8 TB Rear bays: • Up to 2 x 2.5-inch, SAS/SATA/NVMe max 30.72 TB • Up to 2 x EDSFF E3.S Gen5 NVMe (SSD) max 25.6 TB
Power Supplies	• 1400W Titanium 277 VAC or 336 HVDC, hot swap with full redundant • 1800W Titanium 200—240 HLAC or 240 HVDC, hot swap with full redundant • 1400W Platinum 100—240 VAC or 240 HVDC, hot swap with full redundant • 1100W Titanium 100—240 VAC or 240 HVDC, hot swap with full redundant • 1100W -(48—60) VDC, hot swap with full redundancy • 800W -(48—60) VDC, hot swap with full redundancy • 800W Platinum 100—240 VAC or 240 HVDC, hot swap with full redundant • 700 W Titanium 200—240 HLAC or 240 HVDC, hot swap with full redundant
Cooling Options	• Air cooling • Optional Direct Liquid Cooling (DLC) Note: DLC is a rack solution and requires rack manifolds and a cooling distribution unit (CDU) to operate.
Fans	• Standard (STD) fans/High performance Gold (VHP) fans • Up to 4 sets (dual fan module) hot plug fans
Dimensions	• Height – 42.8 mm (1.68 inches) • Width – 482 mm (18.97 inches) • Depth – 822.88 mm (32.39 inches) with bezel 809.04 mm (31.85 inches) without bezel
Form Factor	1 U rack server
Embedded Management	• iDRAC9 • iDRAC Direct • iDRAC RESTful API with Redfish • iDRAC Service Module • Quick Sync 2 wireless module
Bezel	Optional LCD bezel or security bezell
OpenManage Software	• OpenManage Enterprise • OpenManage Power Manager plugin • OpenManage Service plugin • OpenManage Update Manager plugin • CloudIQ for PowerEdge plug in • OpenManage Enterprise Integration for VMware vCenter • OpenManage Integration for Microsoft System Center • OpenManage Integration with Windows Admin Center
Mobility	OpenManage Mobile
OpenManage Integrations	• BMC Truesight • Microsoft System Center • OpenManage Integration with ServiceNow • Red Hat Ansible Modules • Terraform Providers • VMware vCenter and vRealize Operations Manager
Security	• Cryptographically signed firmware • Data at Rest Encryption (SEDs with local or external key mgmt) • Secure Boot • Secure Erase • Secured Component Verification (Hardware integrity check) • Silicon Root of Trust • System Lockdown (requires iDRAC9 Enterprise or Datacenter) • TPM 2.0 FIPS, CC-TCG certified, TPM 2.0 China NationZ
Embedded NIC	2 x 1 GbE LOM card (optional)

Feature	Technical Specifications	
Network options	• 1 x OCP card 3.0 (optional) Note: The system allows either LOM card or an OCP card or both to be installed in the system. • 1 x Managemnet Interface Card (MIC) to support Dell Data Processing Unit (DPU card) (optional) Note: The system allows either LOM card or MIC card to be installed in the system.	
GPU Options	Up to 3 x 75 W SW	
Ports	Front Ports • 1 x iDRAC Direct (Micro-AB USB) port • 1 x USB 2.0 • 1 x VGA	Rear Ports • 1 x Dedicated iDRAC Ethernet port • 1 x USB 2.0 • 1 x USB 3.0 • 1 x Serial (optional) • 1 x VGA (optional for Direct Liquid Cooling configuration)l
	Internal Ports • 1 x USB 3.0 (optional)	
PCIe	Up to three PCIe slots : • Slot 1 : 1 x16 Gen5 Full height, 3/4 length, Half length or 1 x8/ 1 x16 Gen 5 or 1 x16 Gen 4 Low profile, Half length • Slot 2 : 1 x16 Gen5 Full height, 3/4 length, Half length or 1 x16 Gen 5 or 1 x16 Gen 4 Low profile, Half length • Slot 3 : 1 x8/ 1 x16 Gen 5 or 1 x16 Gen 4 Low profile, Half length	
Operating System and Hypervisors	• Canonical Ubuntu Server LTS • Microsoft Windows Server with Hyper-V • Red Hat Enterprise Linux • SUSE Linux Enterprise Server • VMware ESXi For specifications and interoperability details, see Dell.com/OSsupport.	
OEM-ready version available	From bezel to BIOS to packaging, your servers can look and feel as if they were designed and built by you. For more information, visit Dell.com -> Solutions -> OEM Solutions.	

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June 2024

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Specification Sheet

PowerEdge R760

Provides performance and versatility as needed to address your most demanding applications

The new Dell PowerEdge R760 is a 2U, two-socket rack server. Gain the performance you need with this full-featured enterprise server, designed to optimize even the most demanding workloads like Artificial Intelligence and Machine Learning.

Max Performance

- Add up to two 4th Generation Intel Xeon Scalable or Intel Xeon Max processors with up to 56 cores or two 5th Generation Intel Xeon Scalable processors with up to 64 cores for faster and more accurate processing performance.
- Accelerate in-memory workloads with up to 32 DDR5 RDIMMS up to 4800 MT/sec for 1DPC when using 4th Gen Intel Xeon Scalable processors of 32 DDR5 RDIMMS up to 5600 MT/sec for 1DPC when using 5th Gen Intel Xeon Scalable processors.
- Support for GPUs including 2 x double-wide or 6 x single-wide for workloads requiring acceleration.

Air cooled at peak performance

- New Smart Flow chassis optimizes airflow to support the highest core count CPUs in an air-cooled environment within the current IT infrastructure.
- Support for up to 16 x 2.5” drives and 2 x 350 watt processors.

Gain agility

- Achieve maximum efficiency with multiple chassis designs that tailor to your desired workloads and business objectives.
- Storage options include up to 12 x 3.5” SAS3/SATA; or up to 24 x 2.5” SAS4/SATA, plus up to 24 x NVMe U.2 Gen4, 16 x NVMe E3.S Gen5.
- Multiple Gen4 and Gen5 riser configurations (up to 8 x PCIe slots) with interchangeable components that seamlessly integrate to address customer needs over time.

Cyber Resilient Architecture for Zero Trust IT environment & operations

Security is integrated into every phase of the PowerEdge lifecycle, including protected supply chain and factory-to-site integrity assurance. Silicon-based root of trust anchors end-to-end boot resilience while Multi-Factor Authentication (MFA) and role-based access controls ensure trusted operations.

Increase efficiency and accelerate operations with autonomous collaboration

The Dell OpenManage™ systems management portfolio delivers a secure, efficient, and comprehensive solution for PowerEdge servers. Simplify, automate and centralize one-to-many management with the OpenManage Enterprise console and iDRAC.

Sustainability

From recycled materials in our products and packaging, to thoughtful, innovative options for energy efficiency, the PowerEdge portfolio is designed to make, deliver, and recycle products to help reduce the carbon footprint and lower your operation costs. We even make it easy to retire legacy systems responsibly with Dell Technologies Services.

Rest easier with Dell Technologies Services

Maximize your PowerEdge Servers with comprehensive services ranging from Consulting, to ProDeploy and ProSupport suites, Data Migration and more – available across 170 locations and backed by our 60K+employees and partners.

PowerEdge R760

The Dell PowerEdge R760 offers powerful performance in a purpose-built, cyber resilient, mainstream server. Ideal for:

- Mixed Workload Standardization
- Database and Analytics
- Virtual Desktop Infrastructure

Feature	Technical Specifications
Processor	• Up to two 4th Generation Intel Xeon Scalable or Intel Xeon Max processors with up to 56 cores per processor and with optional Intel® QuickAssist Technology • Up to two 5th Generation Intel Xeon Scalable processors with up to 64 cores per processor
Memory	• 32 DDR5 DIMM slots, supports RDIMM 8 TB max, • Speeds up to 4800 MT/s on the 4th Generation Intel Xeon Scalable or Intel Xeon Max processors • Speeds up to 5600 MT/s on the 5th Generation Intel Xeon Scalable processors • Supports registered ECC DDR5 DIMMs only
Storage controllers	• Internal Controllers: PERC H965i, PERC H755, PERC H755N, PERC H355 • External Controller: PERC H965e • Internal Boot: Boot Optimized Storage Subsystem (BOSS-N1): HWRAID 2 x M.2 NVMe SSDs or USB • SAS HBA (non-RAID): HBA355e, HBA355i, HBA465i • Software RAID: S160
Drive Bays	Front bays: • Up to 12 x 3.5-inch SAS/SATA (HDD/SSD) max 240 TB • Up to 8 x 2.5-inch SAS/SATA/NVMe (HDD/SSD) max 122.88 TB • Up to 16 x 2.5-inch SAS/SATA/NVMe (HDD/SSD) max 245.76 TB • Up to 16 x EDSFF E3.S Gen5 NVMe (SSD) max 122.88 TB • Up to 24 x 2.5-inch SAS/SATA/NVMe (HDD/SSD) max 368.64 TB Rear bays: • Up to 2 x 2.5-inch SAS/SATA/NVMe (HDD/SSD) max 30.72 TB • Up to 4 x 2.5-inch SAS/SATA/NVMe (HDD/SSD) max 61.44 TB • Up to 4 x EDSFF E3.S Gen5 NVMe (SSD) max 30.72 TB
Power Supplies	• 3200 W Titanium 277 VAC or 336 HVDC, hot swap redundant • 2800 W Titanium 200—240 HLAC or 240 HVDC, hot swap redundant • 2400 W Platinum 100—240 VAC or 240 HVDC, hot swap redundant • 1800 W Titanium 200—240 HLAC or 240 HVDC, hot swap redundant • 1400 W Titanium 277 VAC or 336 HVDC, hot swap redundant • 1400 W Platinum 100—240 VAC or 240 HVDC, hot swap redundant • 1100 W Titanium 100—240 VAC or 240 HVDC, hot swap redundant • 1100 W -(48—60) VDC, hot swap redundant • 800 W Platinum 100—240 VAC or 240 HVDC, hot swap redundant • 700 W Titanium 200—240 HLAC or 240 HVDC, hot swap redundant
Cooling Options	• Air cooling • Optional Direct Liquid Cooling (DLC) Note: DLC is a rack solution and requires rack manifolds and a cooling distribution unit (CDU) to operate.
Fans	• Standard (STD) fans/High performance Silver (HPR Silver) fans/ High performance Gold (HPR Gold) fans • Up to 6 hot plug fans
Dimensions	• Height – 86.8 mm (3.41 inches) • Width – 482 mm (18.97 inches) • Depth – 772.13 mm (30.39 inches) with bezel 758.29 mm (29.85 inches) without bezel
Form Factor	2U rack server
Embedded Management	• iDRAC9 • iDRAC Direct • iDRAC RESTful API with Redfish • iDRAC Service Module • Quick Sync 2 wireless module
Bezel	Optional LCD bezel or security bezel
OpenManage Software	• CloudIQ for PowerEdge plug in • OpenManage Enterprise • OpenManage Enterprise Integration for VMware vCenter • OpenManage Integration for Microsoft System Center • OpenManage Integration with Windows Admin Center • OpenManage Power Manager plugin • OpenManage Service plugin • OpenManage Update Manager plugin
Mobility	OpenManage Mobile
OpenManage Integrations	• BMC Truesight • Microsoft System Center • OpenManage Integration with ServiceNow • Red Hat Ansible Modules • Terraform Providers • VMware vCenter and vRealize Operations Manager
Security	• Cryptographically signed firmware • Data at Rest Encryption (SEDs with local or external key mgmt) • Secure Boot • Secure Erase • Secured Component Verification (Hardware integrity check) • Silicon Root of Trust • System Lockdown (requires iDRAC9 Enterprise or Datacenter) • TPM 2.0 FIPS, CC-TCG certified, TPM 2.0 China NationZ
Embedded NIC	2 x 1 GbE LOM card (optional)

Feature	Technical Specifications	
Network options	• 1 x OCP card 3.0 (optional) Note: The system allows either LOM card or an OCP card or both to be installed in the system. • 1 x Management Interface Card (MIC) to support Dell Data Processing Unit (DPU) card (optional) Note: The system allows either LOM card or MIC card to be installed in the system.	
GPU Options	Up to 2 x 350 W DW and 6 x 75 W SW	
Ports	Front Ports • 1 x iDRAC Direct (Micro-AB USB) port • 1 x USB 2.0 • 1 x VGA	Rear Ports • 1 x Dedicated iDRAC Ethernet port • 1 x USB 2.0 • 1 x USB 3.0 • 1 x VGA • 1 x Serial (optional) • 1 x VGA (optional for Direct Liquid Cooling configuration)
	Internal Ports • 1 x USB 3.0 (optional)	
PCIe	Up to eight PCIe slots: • Slot 1: 1 x8 Gen5 or 1 x8/1 x16 Gen4 Full height, Half length or 1 x16 Gen4 Full height, Full length • Slot 2: 1 x8/1 x16 Gen5 or 1 x8 Gen4 Full height, Half length or 1 x16 Gen5 Full height, Full length • Slot 3: 1 x16 Gen4 Low profile, Half length • Slot 4: 1 x8 Gen4 Full height, Half length • Slot 5: 1 x8/1 x16 Gen4 Full height, Half length or 1 x16 Gen4 Full height, Full length • Slot 6: 1 x16 Gen4 Low profile, Half length • Slot 7: 1 x8/1 x16 Gen5 or 1 x8 Gen4 Full height, Half length or 1 x16 Gen5 Full height, Full length • Slot 7 SNAPI: 1 x16 Gen5 Full height, Half length • Slot 8: 1 x8 Gen5 or 1 x8 Gen4 Full height, Half length	
Operating System and Hypervisors	• Canonical Ubuntu Server LTS • Microsoft Windows Server with Hyper-V • Red Hat Enterprise Linux • SUSE Linux Enterprise Server • VMware ESXi For specifications and interoperability details, see Dell.com/OSsupport.	
OEM-ready version available	From bezel to BIOS to packaging, your servers can look and feel as if they were designed and built by you. For more information, visit Dell.com -> Solutions -> OEM Solutions.	

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June 2024

1 ACTIVE IQ UNIFIED MANAGER

NetApp Active IQ Unified Manager offers comprehensive monitoring and key management capabilities for NetApp ONTAP to help manage your storage systems' availability, capacity, protection, and performance risks. Unified Manager can be deployed on a Linux or Windows server or as a virtual appliance on a VMware host.

In today's data-driven business environment, organizations constantly face the challenges of managing extensive and complex data storage infrastructures. Efficiently monitoring, optimizing, and ensuring the health of these systems is crucial for maintaining uninterrupted operations and supporting business continuity.

With the ever-increasing volume and velocity of data, IT departments require robust solutions that streamline management tasks and provide predictive analytics to address potential issues preemptively.

A COMPREHENSIVE STORAGE MANAGEMENT SOLUTION

NetApp® Active IQ® Unified Manager (AIQUM) is a comprehensive, monitoring, alerting, reporting, and active management solution for infrastructure engineers and IT generalists. It manages and monitors performance, capacity, and health in ONTAP systems. Unified Manager collects, retains, and analyzes NetApp storage performance statistics so storage admins can quickly troubleshoot and resolve issues. Unified Manager can be deployed on a Linux or Windows server or as a virtual appliance on a VMware host. Unified Manager's awareness of VMware environments simplifies the provisioning and management of storage workloads, offers a clear analysis of workload performance issues, and facilitates more effective resource utilization.

Unified Manager integrates with the Active IQ Portal, the cloud-based intelligence engine that provides predictive analytics and actionable intelligence for your entire NetApp environment. The Active IQ Portal delivers community intelligence, risk assessments, and recommendations to dark (secure) and non-dark sites.

Active IQ Portal receives telemetry data daily from your systems and hundreds of thousands of NetApp assets worldwide. This adds to a multipetabyte data lake that intelligently processes trillions of data points each month. Fueled by a very large and highly diverse community, Active IQ Portal uses the latest predictive analytics techniques and machine learning algorithms to derive wisdom from this rich data set. It continuously assesses telemetry data, drawing on trillions of real-time and historical diagnostic records to identify potential problems before they negatively impact your business.

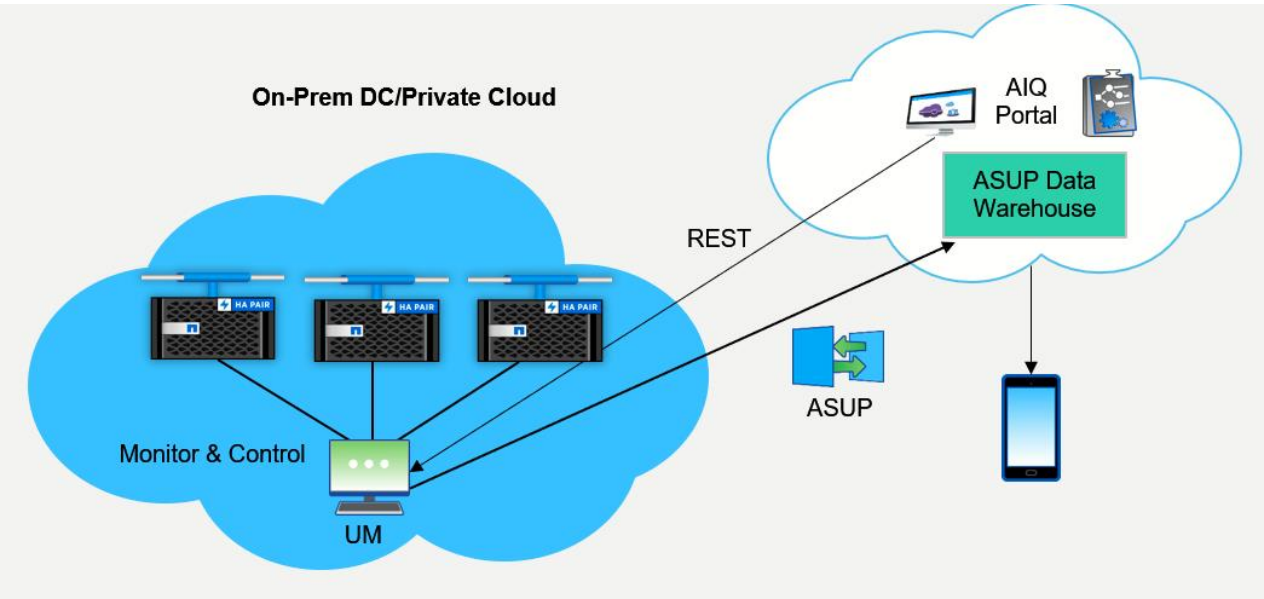


Figure 1: Active IQ Portal and Unified Manager Integration *– Use Active IQ Portal for data center-wide insights and recommendations and Unified Manager to troubleshoot, automate, and customize monitoring and management.*

With the integration of Active IQ Portal and Unified Manager, you get:

- Predictive analytics integration
- Automated workflows
- Performance monitoring and reporting
- Proactive health and capacity management
- Simplified and intuitive graphical user interface
- Health and risk alerts

PREDICTIVE ANALYTICS INTEGRATION

The seamless integration with the Active IQ Portal enhances Unified Manager's capabilities by incorporating predictive analytics and actionable intelligence derived from community intelligence and a vast multipetabyte data lake. This empowers organizations with upgrade recommendations, automated alert resolutions, and risk assessments.

AUTOMATED WORKFLOWS

Active IQ Unified Manager reduces the complexity of storage management and streamlines routine tasks with policy-based automation. This gives IT teams the ability to focus on strategic initiatives rather than routine maintenance activities.

PERFORMANCE MONITORING AND REPORTING

Unified Manager delivers real-time insights into storage performance so administrators can quickly identify and resolve bottlenecks, thus maintaining optimal system performance. Unified Manager provides a holistic view of storage health, leveraging real-time analytics to monitor the status and trends of ONTAP systems, ensuring that administrators are equipped to maintain optimal performance and capacity. You can also gain valuable insights for decision-making and

compliance purposes through the ability to create custom reports tailored to your specific organizational needs.

PROACTIVE HEALTH AND CAPACITY MANAGEMENT

Stay ahead of potential issues with AI-driven insights that guide capacity planning and health management. AIQUM identifies underutilized resources and provides recommendations for cost-saving measures, optimizing the overall investment in storage infrastructure. With AIQUM's predictive analytics, you'll be well-prepared for storage needs. It continuously monitors storage utilization and identifies trends, enabling you to plan capacity effectively and avoid storage constraints or performance bottlenecks. Through intelligent capacity management, AIQUM helps you optimize storage investments, avoiding overprovisioning while preparing you for future growth.

SIMPLIFIED AND INTUITIVE GRAPHICAL USER INTERFACE

Unified Manager offers a simplified and intuitive graphical user interface (GUI) for monitoring and managing the health and performance of your storage environment. This GUI enhances the overall user experience with an integrated view of how your storage infrastructure is performing. Administrators can log in to a single URL and monitor health and performance attributes from a single location. The simplified navigation makes it easy to see the higher-level actions and dashboards up front, so you do not have to drill down to each object to view information. It simplifies complex data management tasks for swift decision-making and action. This user-friendly approach means faster response times and reduced training costs. This means you can accomplish more tasks with just one or two clicks, giving you more control with less effort.

HEALTH AND RISK ALERTS

Unified Manager generates proactive health and risk notifications so IT teams can address issues promptly and maintain system integrity. In addition to reporting security status, Unified Manager generates security events for any cluster or SVM that has security violations and potential ransomware attacks. You can track these issues in the Event Management inventory page and configure alerts for these events to notify the storage administrator when new security events occur. These proactive alerts and automated fixes minimize the risk of downtime, ensuring your business operations remain uninterrupted.

ADVANCED DATA PROTECTION AND ANTI-RANSOMWARE

With comprehensive data protection features and state-of-the-art anti-ransomware capabilities, Active IQ Unified Manager defends your data and fortifies your reputation as a secure and reliable enterprise. The introduction of anti-ransomware monitoring in version 9.10 and the expanded capabilities in subsequent versions, including intuitive visualizations and management actions, offer a strong defense against ransomware attacks, safeguarding critical data. AIQUM raises events whenever ONTAP systems publish Event Management System events for the ransomware attack detection feature on a volume level and storage VM level. It also introduces several management actions for enabling and disabling anti-ransomware features through fix-it buttons. Subsequent versions have expanded on these capabilities, including 9.11, which includes intuitive visualization of the volumes and storage VMs’ anti-ransomware status. You get a consolidated view on the Security dashboard for the Volume anti-ransomware status as well as storage VM status for each cluster.

API ENHANCEMENTS

Continuous improvements to APIs bolster Unified Manager's data protection capabilities, ensuring that storage administrators have the most advanced tools to secure their storage environments. The inclusion of REST APIs provides the flexibility to integrate Unified Manager with other systems and applications, allowing for custom automation and enhanced interoperability within the IT ecosystem. AIQUM's compatibility with VMware and REST APIs facilitates seamless integration with existing systems, enhancing your IT agility and future-proofing your storage investments.

ACTIVE IQ UNIFIED MANAGER DASHBOARD

The Dashboard gives you the ability to perform management actions on specific issues diagnosed by Unified Manager. It has several panels that provide high-level capacity and performance statistics for the clusters in your environment.

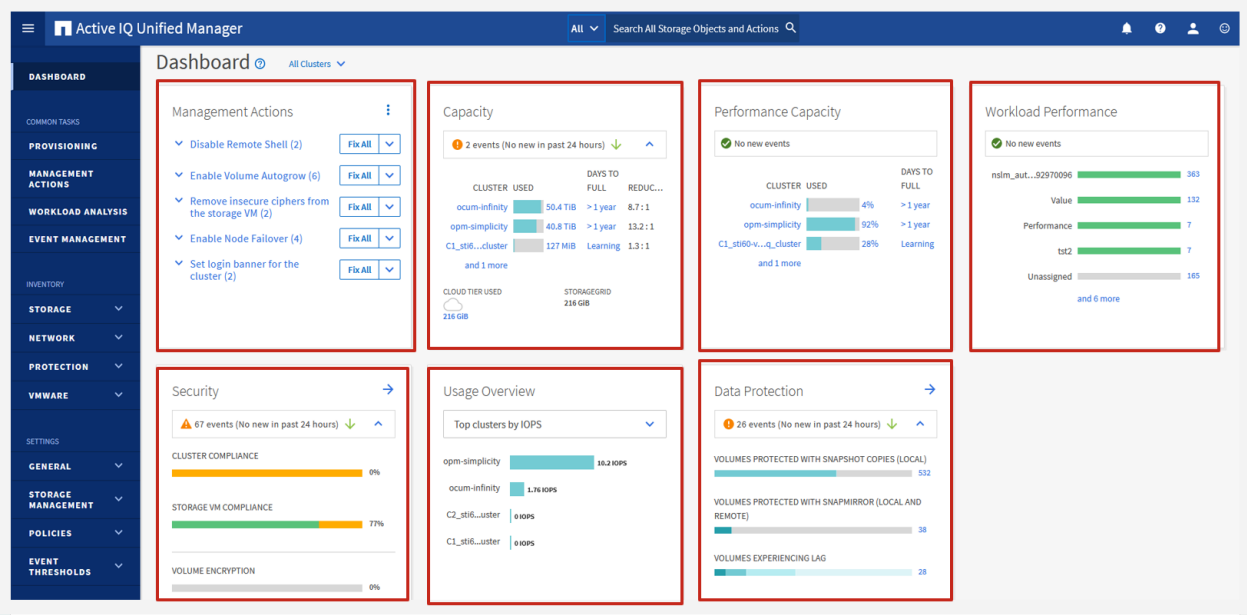


Figure 2: Active IQ Unified Manager dashboard in detail – *The redesigned dashboard introduces an enhanced left-hand navigation pane that groups features according to functionality for ease of user access.*

The Dashboard page has "widgets" that display the information on a high level:

- **Management Actions panel**. Lists the issues and fixes that Unified Manager can make to resolve certain events.
- **Capacity panel**. Shows the capacity used on the local tier and cloud tier, projection of days to full, and the data reduction obtained.
- **Performance Capacity panel**. Shows the performance capacity consumption and the projection of days to full.
- **Workload Performance panel**. Shows the conformance of the workloads to the applied performance service levels.

- **Security panel**. Shows the cluster and SVM level security conformance with respect to the ONTAP Security Hardening Guide.
- **Usage Overview panel**. Choose to view clusters sorted by the highest IOPS, throughput, or capacity.
- **Data Protection Summary panel**. Shows the details of Snapshot and the SnapMirror relationships.

Introduction

ONTAP 9

NetApp
March 06, 2025

Table of Contents

Introduction

SnapMirror active sync overview in ONTAP

SnapMirror active sync (also referred to as SnapMirror Business Continuity *[SM-BC]*), enables business services to continue operating even through a complete site failure, supporting applications to fail over transparently using a secondary copy. There is no manual intervention or custom scripting required to trigger a failover with SnapMirror active sync.

Available beginning with ONTAP 9.9.1, SnapMirror active sync is supported on AFF clusters, All-Flash SAN Array (ASA) clusters, and C-Series (AFF or ASA). Primary and secondary clusters must be of the same type: either ASA or AFF. SnapMirror active sync protects applications with iSCSI or FCP LUNs.

Beginning with ONTAP 9.15.1, SnapMirror active sync supports a symmetric active/active capability. Symmetric active/active enable read and write I/O operations from both copies of a protected LUN with bidirectional synchronous replication so that both LUN copies can serve I/O operations locally. Prior to ONTAP 9.15.1, SnapMirror active sync only supports asymmetric active/active configurations, in which data on the secondary site is proxied to a LUN. Beginning with ONTAP 9.16.1 GA, symmetric active/active is also supported in four-node ONTAP clusters.

Beginning July 2024, content from technical reports previously published as PDFs has been integrated with ONTAP product documentation. The ONTAP SnapMirror active sync documentation now includes content from *TR-4878: SnapMirror active sync*.

Benefits

SnapMirror active sync provides the following benefits:

- Continuous availability for business-critical applications.
- Ability to host critical applications alternately from primary and secondary sites.
- Simplified application management using consistency groups for dependent write-order consistency.
- The ability to test failover for each application.
- Instantaneous creation of mirror clones without impacting application availability.
- The ability to deploy protected and non-protected workloads in the same ONTAP cluster.
- LUN identity remains the same, so the application sees them as a shared virtual device.
- The ability to reuse secondary clusters with flexibility to create instantaneous clones for application usage for dev-test, UAT or reporting purposes without impacting application performance or availability.

SnapMirror active sync allows you to protect your data LUNs, which enables applications to fail over transparently for the purpose of business continuity in the event of a disaster. For more information, see Use cases.

Key concepts

SnapMirror active sync uses consistency groups and the ONTAP Mediator to ensure your data is replicated and served even in the event of a disaster scenario. When planning your SnapMirror active sync deployment, it is important to understand the essential concepts in SnapMirror active sync and its architecture.

Asymmetry and symmetry

SnapMirror active sync supports asymmetric and, beginning with ONTAP 9.15.1, symmetric active/active solutions. These options refer to how hosts access storage paths and write data. In an asymmetric configuration, data on the secondary site is proxied to a LUN. In a symmetric active/active configuration, both sites are able to access local storage for active I/O.

Symmetric active/active is optimized for clustered applications including VMware vMSC, Windows Failover Cluster with SQL, and Oracle RAC.

For more information, see SnapMirror active sync architecture.

Consistency group

A consistency group is a collection of FlexVol volumes that provide a consistency guarantee for the application workload that must be protected for business continuity.

The purpose of a consistency group is to take simultaneous snapshot images of multiple volumes, thus ensuring crash-consistent copies of a collection of volumes at a point in time. A consistency group ensures all volumes of a dataset are quiesced and then snapped at precisely the same point in time. This provides a data-consistent restore point across volumes supporting the dataset. A consistency group thereby maintains dependent write-order consistency. If you decide to protect applications for business continuity, the group of volumes corresponding to this application must be added to a consistency group so a data protection relationship is established between a source and a destination consistency group. The source and destination consistency must contain the same number and type of volumes.

Constituent

An individual volume or LUN that is part of the consistency group protected in the SnapMirror active sync relationship.

ONTAP Mediator

The ONTAP Mediator receives health information about peered ONTAP clusters and nodes, orchestrating between the two and determining if each node/cluster is healthy and running. ONTAP Mediator provides the health information about:

- Peer ONTAP clusters
- Peer ONTAP cluster nodes
- Consistency groups (which define the failover units in a SnapMirror active sync relationship); for each consistency group, the following information is provided:
  - Replication state: Uninitialized, In Sync, or Out of Sync
  - Which cluster hosts the primary copy
  - Operation context (used for planned failover)

With this ONTAP Mediator health information, clusters can differentiate between distinct types of failures and determine whether to perform an automated failover. ONTAP Mediator is one of the three parties in the SnapMirror active sync quorum along with both ONTAP clusters (primary and secondary). To reach consensus, at least two parties in the quorum must agree to a certain operation.

Beginning with ONTAP 9.15.1, System Manager displays the status of your SnapMirror active sync relationship from either cluster. You can also monitor the ONTAP Mediator's status from either cluster in System Manager. In earlier releases of ONTAP, System Manager displays the status of SnapMirror active sync relationships from the source cluster.

Planned failover

A manual operation to change the roles of copies in a SnapMirror active sync relationship. The primary sites becomes the secondary, and the secondary becomes the primary.

Primary-first and primary bias

SnapMirror active sync uses a primary-first principle that gives preference to the primary copy to serve I/O in case of a network partition.

Primary-bias is a special quorum implementation that improves availability of a SnapMirror active sync protected dataset. If the primary copy is available, primary-bias comes into effect when the ONTAP Mediator is not reachable from both clusters.

Primary-first and primary bias are supported in SnapMirror active sync beginning with ONTAP 9.15.1. Primary copies are designated in System Manager and output with the REST API and CLI.

Automatic unplanned failover (AUFO)

An automatic operation to perform a failover to the mirror copy. The operation requires assistance from the ONTAP Mediator to detect that the primary copy is unavailable.

Out of Sync (OOS)

When the application I/O is not replicating to the secondary storage system, it will be reported as **out of sync**. An out of sync status means the secondary volumes are not synchronized with the primary (source) and that SnapMirror replication is not occurring.

If the mirror state is `Snapmirrored`, this indicates a transfer failure or failure due to an unsupported operation.

SnapMirror active sync supports automatic resync, enabling copies to return to an InSync state.

Beginning with ONTAP 9.15.1, SnapMirror active sync supports automatic reconfiguration in fan-out configurations.

Uniform and non-uniform configuration

- **Uniform host access** means that hosts from both sites are connected to all paths to storage clusters on both sites. Cross-site paths are stretched across distances.
- **Non-uniform host access** means hosts in each site are connected only to the cluster in the same site. Cross-site paths and stretched paths aren't connected.

Uniform host access is supported for any SnapMirror active sync deployment; non-uniform host access is only supported for symmetric active/active deployments.

Zero RPO

RPO stands for recovery point objective, which is the amount of data loss deemed acceptable during a given time period. Zero RPO signifies that no data loss is acceptable.

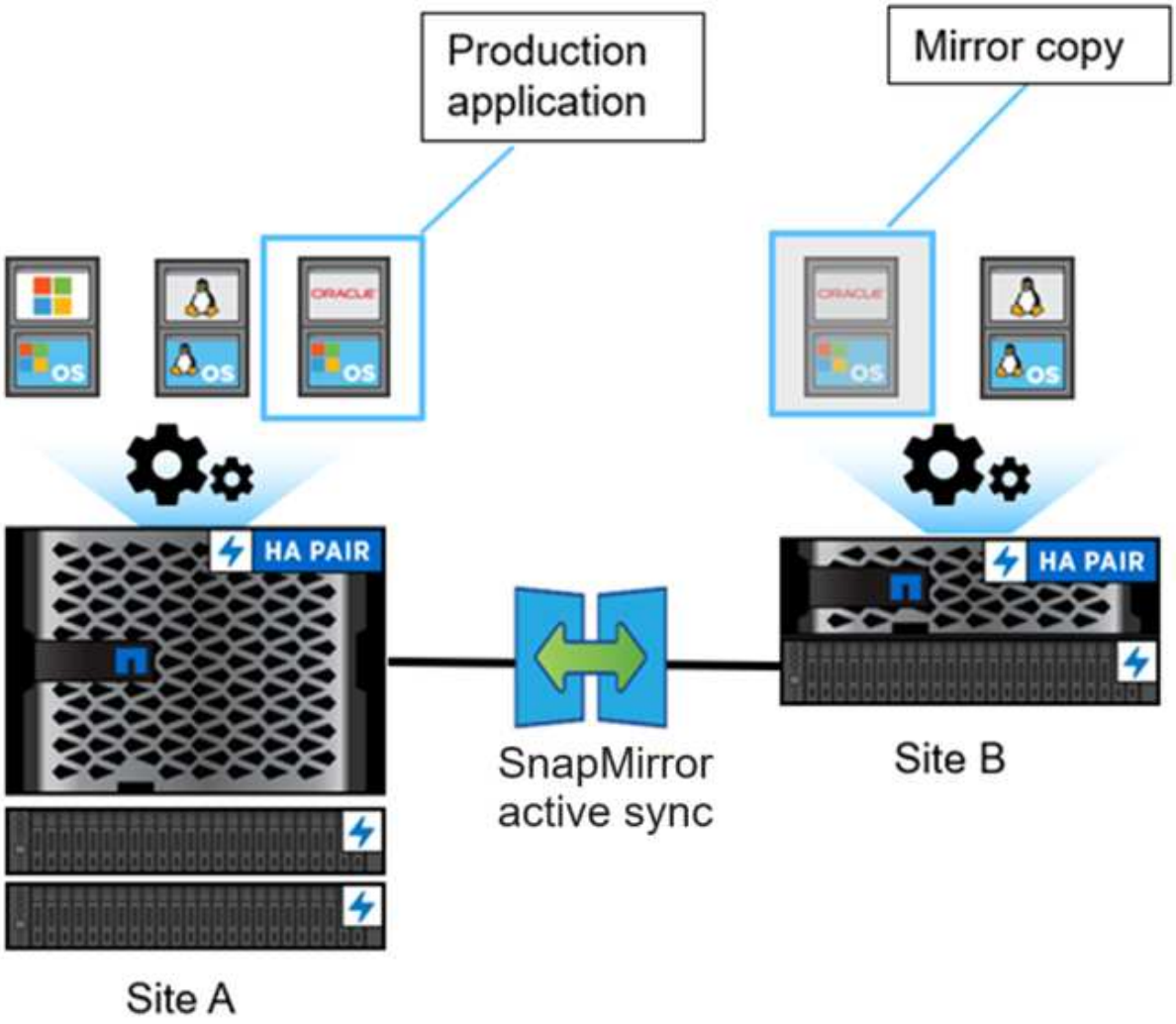
Zero RTO

RTO stands for recovery time objective, which is the amount of time that is deemed acceptable for an application to return to normal operations non-disruptively following an outage, failure, or other data loss event. Zero RTO signifies that no amount of downtime is acceptable.

SnapMirror active sync architecture

The SnapMirror active sync architecture enables active workloads on both clusters, where primary workloads can be served simultaneously from both clusters. Regulations for financial institutions in some countries require businesses to be periodically serviceable from their secondary data centers as well, called “Tick-Tock” deployments, which SnapMirror active sync enables.

The data protection relationship to protect for business continuity is created between the source storage system and destination storage system, by adding the application specific LUNs from different volumes within a storage virtual machine (SVM) to the consistency group. Under normal operations, the enterprise application writes to the primary consistency group, which synchronously replicates this I/O to the mirror consistency group.



Even though two separate copies of the data exist in the data protection relationship, because SnapMirror active sync maintains the same LUN identity, the application host sees this as a shared virtual device with multiple paths while only one LUN copy is being written to at a time. When a failure renders the primary storage system offline, ONTAP detects this failure and uses the Mediator for re-confirmation; if neither ONTAP nor the Mediator are able to ping the primary site, ONTAP performs the automatic failover operation. This

process results in failing over only a specific application without the need for the manual intervention or scripting which was previously required for the purpose of failover.

Other points to consider:

- Unmirrored volumes which exist outside of protection for business continuity are supported.
- Only one other SnapMirror asynchronous relationship is supported for volumes being protected for business continuity.
- Cascade topologies are not supported with protection for business continuity.

ONTAP Mediator

ONTAP Mediator is installed in a third failure domain, distinct from the two ONTAP clusters. Its key role is to act as a passive witness to SnapMirror active sync copies. In the event of a network partition or unavailability of one copy, SnapMirror SnapMirror active sync uses Mediator to determine which copy continues to serve I/O, while discontinuing I/O on the other copy. There are three key components in this setup:

- Primary ONTAP cluster hosting the SnapMirror active sync primary consistency group
- Secondary ONTAP cluster hosting the mirror consistency group
- ONTAP Mediator

The ONTAP Mediator plays a crucial role in SnapMirror active sync configurations as a passive quorum witness, ensuring quorum maintenance and facilitating data access during failures. It acts as a ping proxy for controllers to determine liveliness of peer controllers. Although the Mediator does not actively trigger switchover operations, it provides a vital function by allowing the surviving node to check its partner's status during network communication issues. In its role as a quorum witness, the ONTAP Mediator provides an alternate path (effectively serving as a proxy) to the peer cluster.

Furthermore, it allows clusters to get this information as part of the quorum process. It uses the node management LIF and cluster management LIF for communication purposes. It establishes redundant connections through multiple paths to differentiate between site failure and InterSwitch Link (ISL) failure. When a cluster loses connection with the ONTAP Mediator software and all its nodes due to an event, it is considered not reachable. This triggers an alert and enables automated failover to the mirror consistency group in the secondary site, ensuring uninterrupted I/O for the client. The replication data path relies on a heartbeat mechanism, and if a network glitch or event persists beyond a certain period, it can result in heartbeat failures, causing the relationship to go out-of-sync. However, the presence of redundant paths, such as LIF failover to another port, can sustain the heartbeat and prevent such disruptions.

To summarize, ONTAP Mediator is used for the following purposes:

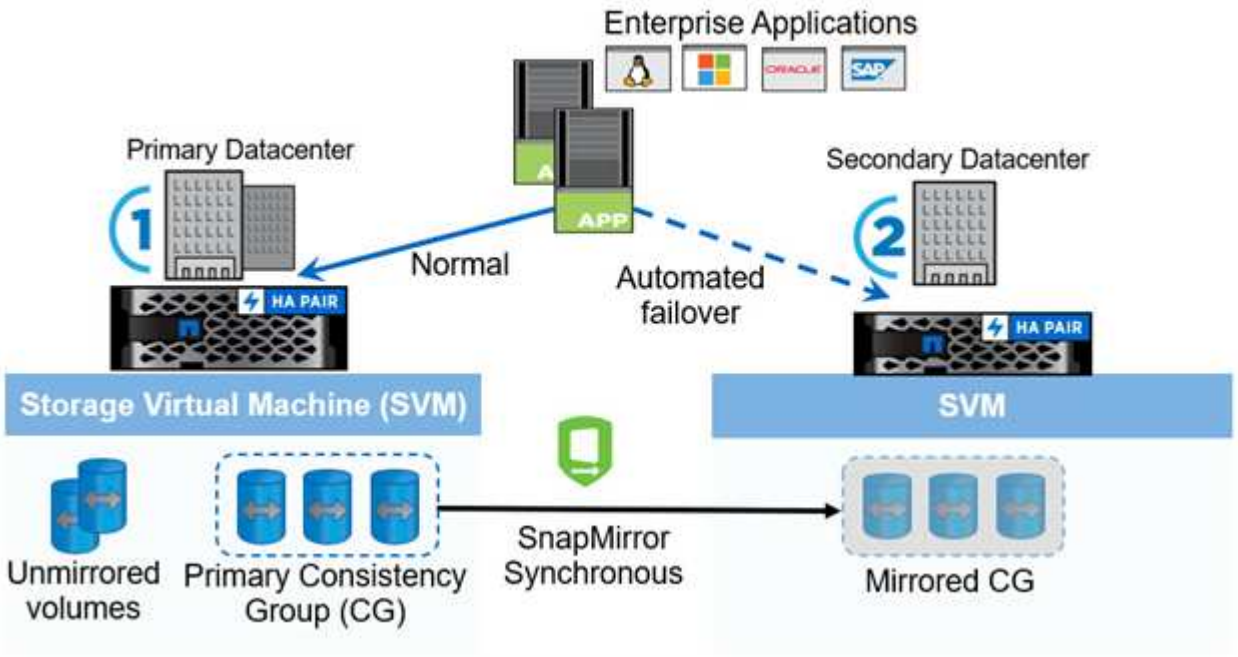
- Establish a quorum
- Continuous availability via automatic failover (AUFO)
- Planned failovers (PFO)

ONTAP Mediator 1.7 can manage ten cluster pairs for the purpose of business continuity.

When the ONTAP Mediator is not available, you cannot perform planned or automated failovers. The application data continues to synchronously replicate without any interruption to for zero data loss.

Operations

The following figure illustrates the design of SnapMirror active sync at a high level.



The diagram shows an enterprise application that is hosted on an storage VM (SVM) at the primary data center. The SVM contains five volumes, three of which are part of a consistency group. The three volumes in the consistency group are mirrored to a secondary data center. In normal circumstances, all write operations are performed to the primary data center; in effect, this data center serves as the source for I/O operations, while the secondary data center serves as a destination.

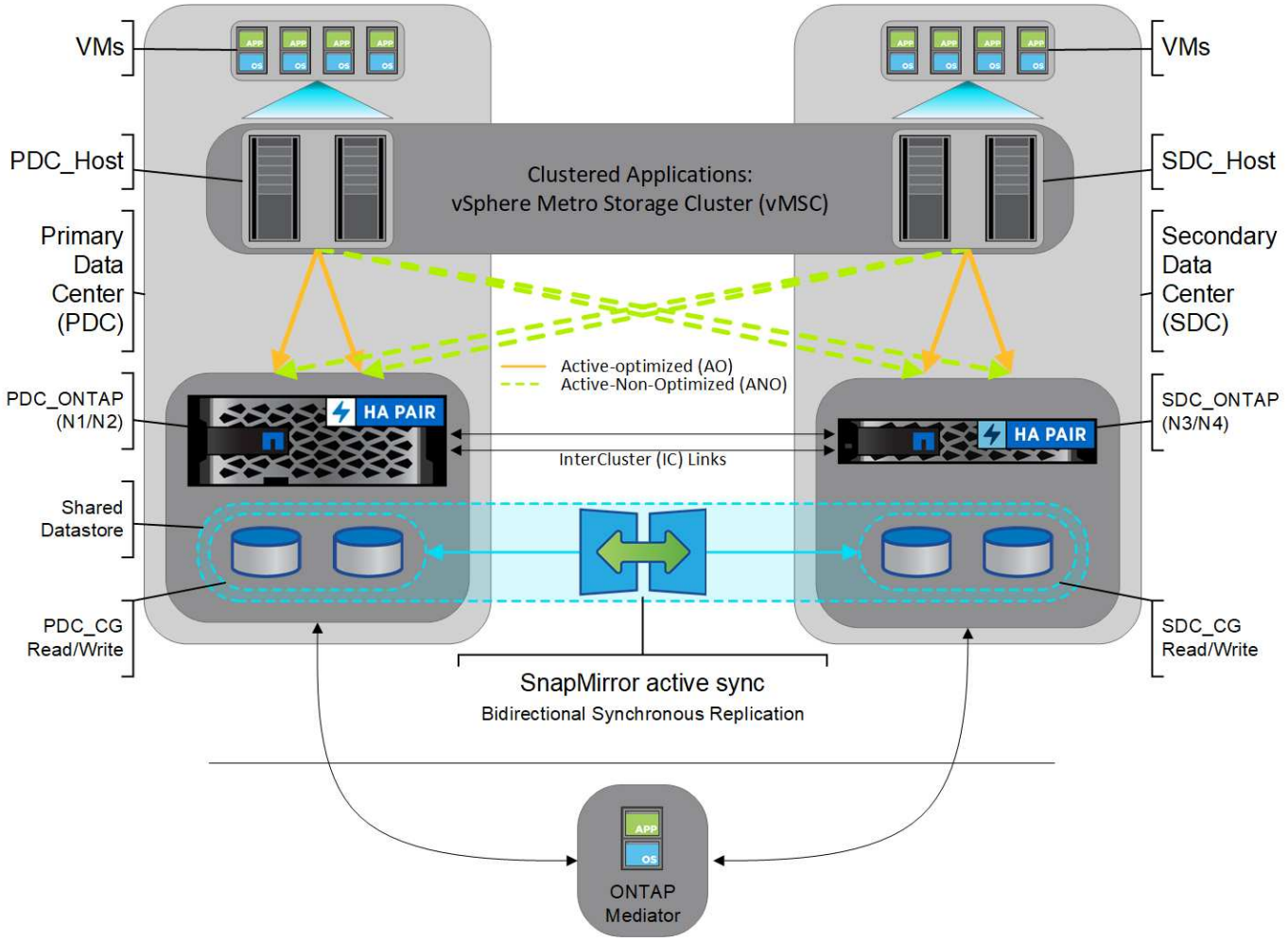
In the event of a disaster scenario at the primary data center, ONTAP directs the secondary data center to act as the primary, serving all I/O operations. Only the volumes that are mirrored in the consistency group are served. Any operations pertaining to the other two volumes on the SVM is be affected by the disaster event.

Symmetric active/active

SnapMirror active sync offers asymmetric and symmetric solutions.

In *asymmetric configurations*, the primary storage copy exposes an active-optimized path and actively serves client I/O. The secondary site uses a remote path for I/O. The storage paths for the secondary site are considered active-non-optimized. Access to the write LUN is proxied from the secondary site.

In *symmetric active/active configurations*, active-optimized paths are exposed on both sites, are host specific, and are configurable, meaning hosts on either side are able to access local storage for active I/O. Beginning with ONTAP 9.16.1, symmetric active/active is supported on clusters with up to four nodes.



Symmetric active/active is targeted for clustered applications including VMware Metro Storage Cluster, Oracle RAC, and Windows Failover Clustering with SQL.

Use cases for SnapMirror active sync

The demands of a globally connected business environment demand rapid recovery of business-critical application data with zero data loss in the event of a disruption such as a cyber attack, power outage, or natural disaster. These demands are heightened in arenas such as finance and those adhering to regulatory mandates such as the General Data Protection Regulation (GDPR).

SnapMirror active sync provides the following use cases:

Application deployment for zero recovery time objective (RTO)

In a SnapMirror active sync deployment, you have a primary and secondary cluster. A LUN in the primary cluster (`1LP`) has a mirror (`L1s`) on the secondary; both LUNs share the same serial ID and are reported as read-write LUNs to the host. Read and write operations, however, are only serviced to the primary LUN, `1LP`. Any writes to the mirror `L1S` are served by proxy.

Application deployment for zero RTO or transparent application failover (TAF)

TAF is based on host MPIO software-based path failover to achieve non-disruptive access to the storage. Both LUN copies—for example, primary (L1P) and mirror copy (L1S)--have the same identity (serial number) and

are reported as read-writable to the host. However, reads and writes are serviced only by the primary volume. I/Os issued to the mirror copy are proxied to the primary copy. The host's preferred path to L1 is VS1:N1 based on asymmetric logical unit access (ALUA) access state Active Optimized (A/O). ONTAP Mediator is required as part of the deployment, primarily to perform failover (planned or unplanned) in the event of a storage outage on the primary.

SnapMirror active sync uses ALUA, a mechanism that allows an application host multipathing software with paths advertised with priorities and access availability for the application host communication with the storage array. ALUA marks active optimized paths to the controllers owning the LUN and others as active non-optimized paths, used only if the primary path fails.

Clustered applications

Clustered applications including VMware Metro Storage Cluster, Oracle RAC, and Windows Failover Clustering with SQL require simultaneous access so the VMs can be failed over to other site without any performance overhead. SnapMirror active sync symmetric active/active serves IO locally with bidirectional replication to meet the requirements of clustered applications. Beginning with ONTAP 9.16.1, symmetric active/active is supported in a configuration in four-node clusters, expanding from the two-node cluster limit in ONTAP 9.15.1.

Disaster scenario

Synchronously replicate multiple volumes for an application between sites at geographically dispersed locations. You can automatically failover to the secondary copy in case of disruption of the primary, thus enabling business continuity for tier one applications. When the site hosting the primary cluster experiences a disaster, the host multipathing software marks all paths through the cluster as down and uses paths from the secondary cluster. The result is a non-disruptive failover enabled by ONTAP Mediator to the mirror copy.

Windows failover

SnapMirror active sync provides flexibility with easy-to-use application-level granularity and automatic failover. SnapMirror active sync uses proven SnapMirror synchronous replication over IP network to replicate data at high speeds over LAN or WAN, to achieve high data availability and fast data replication for your business-critical applications such as Oracle, Microsoft SQL Server, and so on, in both virtual and physical environments.

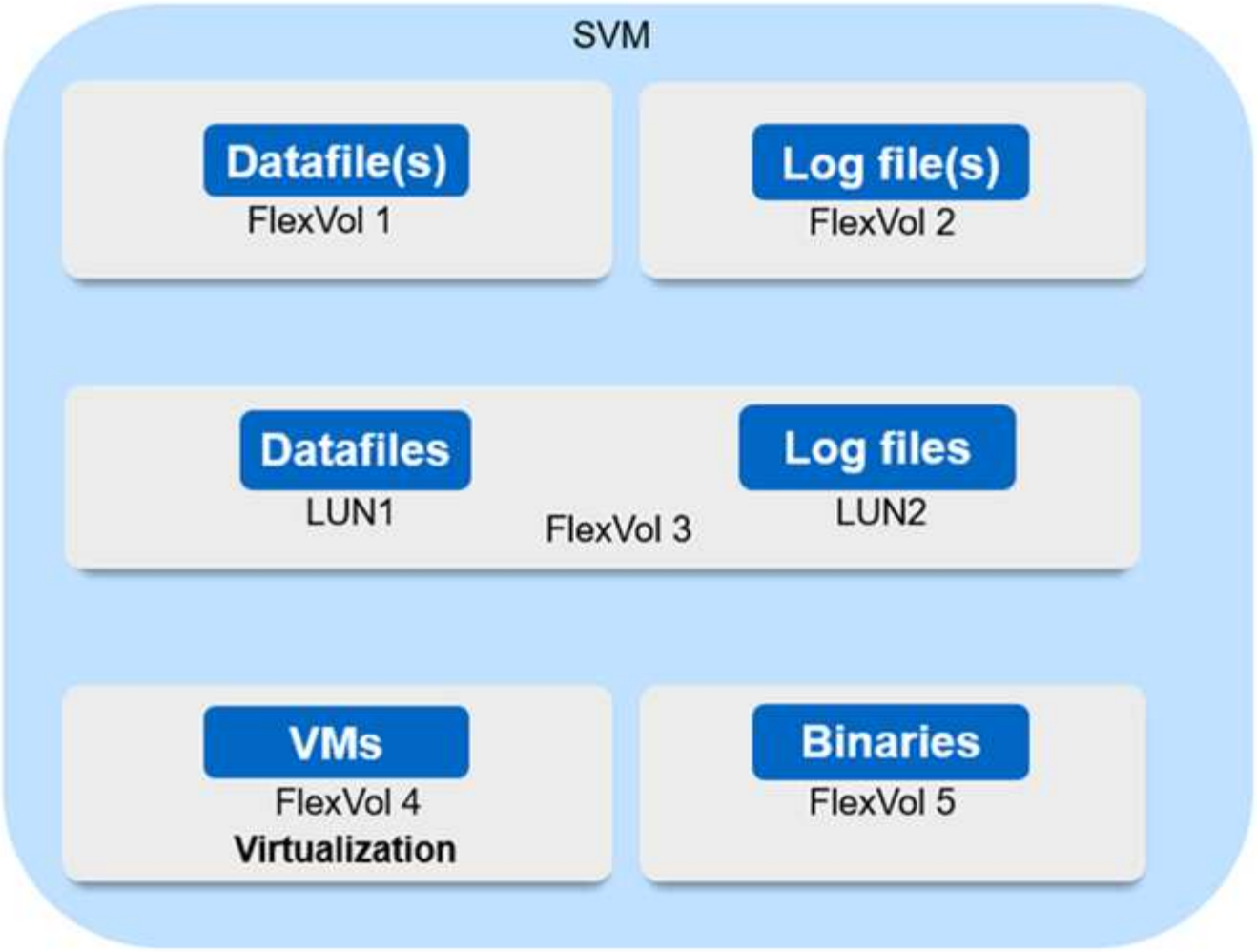
SnapMirror active sync enables mission-critical business services to continue operating even through a complete site failure, with TAF to the secondary copy. No manual intervention or no additional scripting are required to trigger this failover.

Deployment strategy and best practices for SnapMirror active sync

It is important that your data protection strategy clearly identifies the workloads threats need to be protected for business continuity. The most critical step in your data protection strategy is to have clarity in your enterprise application data layout so that you can decide how you are distributing the volumes and protecting business continuity. Because failover occurs at the consistency group level on a per-application basis, make sure to add the necessary data volumes to the consistency group.

SVM configuration

The diagram captures a recommended storage VM (SVM) configuration for SnapMirror active sync.



- For data volumes:
  - Random read workloads are isolated from sequential writes; therefore, depending on the database size, the data and log files are typically placed on separate volumes.
    - For large critical databases, the single data file is on FlexVol 1 and its corresponding log file is on FlexVol 2.
    - For better consolidation, small-to-medium-size noncritical databases are grouped such that all the data files are on FlexVol 1 and their corresponding log files are on FlexVol 2. However, you will lose application-level granularity through this grouping.
  - Another variant is to have all the files within the same FlexVol 3, with data files in LUN1 and its log files in LUN 2.
- If your environment is virtualized, you would have all the VMs for various enterprise applications shared in a datastore. Typically, the VMs and application binaries are asynchronously replicated using SnapMirror.

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Trademark information

DATASHEET

NETAPP ASA

Simple, powerful, affordable block-optimized storage.

The challenge
Organizations have long had to choose between operational simplicity and high-end capabilities like scale-out and advanced data management in block storage. IT decision makers have been forced to compromise, and that has impeded infrastructure modernization efforts.

The solution
With the block-optimized NetApp® ASA systems, NetApp eliminates that trade-off — via simple, powerful, scale-out all-flash storage with advanced data management and protection features at an extremely affordable price. NetApp ASA enables storage modernization for every organization.

The ASA systems deliver a simplified and consistent experience for VMware apps, mission-critical databases, and other SAN workloads. Built on a scale-out, end-to-end NVMe architecture, NetApp ASA systems offer industry-leading availability and performance, along with simplified data management across your hybrid cloud.

All-flash block storage powered by ONTAP

NetApp ASA systems modernize your SAN infrastructure, accelerating business-critical applications, making data always available, and simplifying storage management. The ASA family includes A-Series models designed for your most performance-demanding and mission-critical applications, and C-Series models optimized for cost-effective deployment of large-capacity and general-purpose applications. Together, the ASA systems:

- Deliver exceptional performance that improves customers' experience and reduces time to results.
- Slash operational risk and enhance business continuity by keeping business-critical data available, protected, and secure.
- Transform your SAN environment with modern, affordable block storage that costs up to 50% less than other storage vendors, with far better TCO.

Keep critical data available, protected, and secure

As organizations become more data driven, the business impact of data loss can be increasingly dramatic—and costly. IT must protect data from both internal and external threats, ensure data availability, eliminate maintenance disruptions, and quickly recover from failures.

Access your data with continuous availability
ASA systems provide continuous access to data during unplanned outages by using symmetric, active-active multipathing. With both active controllers capable of communicating to a LUN, multipathing gives you uninterrupted access to your data with rapid failover recovery.

NetApp business continuity solutions help you maintain constant data availability with zero data loss and zero downtime in the event of a human-made or natural disaster. NetApp SnapMirror® active sync provides application-level protection with automatic failover, enabling mission-critical business services to keep operating, even during a complete site failure. SnapMirror active sync also offers symmetric active/active support for block workloads on ASA systems across 2-node configuration at each site. It enables higher scalability and better performance, allowing you to distribute workloads across cluster without compromising the ability to protect your mission-critical workloads against disasters.

Integrated data protection
ASA systems come with a full suite of acclaimed NetApp integrated and application-consistent data protection software. Key capabilities include:

- Native space efficiency with cloning and NetApp Snapshot™ copies that reduce storage costs and minimize performance impact.
- NetApp SnapCenter® software that provides application-consistent data protection and clone management to simplify application management.
- NetApp SnapMirror technology that simplifies operations with built-in data protection across the hybrid cloud.

NetApp will warrant Snapshot data recovery in the event of a ransomware attack. If you can't recover your data copies with help from NetApp or partner assistance, NetApp will offer compensation.

Find details here

KEY BENEFITS

Simple

- Leverage a storage solution so simple that anyone can deploy it, manage it, and upgrade it.
- Get up and running in minutes, provision in seconds, and protect in one click; manage directly from vCenter.

Powerful

- Accelerate VMware and database apps with market-leading performance, proven reliability, and intelligent data management.
- Run worry-free with built-in business continuity, a 99.9999% data availability guarantee, and a ransomware recovery guarantee.

Affordable

- Drive unmatched value with an up to 50% upfront price advantage versus other storage vendors, up to 25% lower VMware costs, and better overall ROI.
- Gain leading raw-to-effective capacity and an always-on 4:1 storage efficiency guarantee.

Security everywhere
Encryption and key management help guard your sensitive data on your premises, in the cloud, and in transit. Market-leading anti-ransomware protection for post-attack recovery safeguards your critical data from ransomware attacks and can prevent catastrophic financial consequences. With NetApp's proven and efficient security solutions, you can:

- Protect against threats with multifactor authentication, role-based access control, and multi-admin verification.
- Achieve FIPS 140-2 compliance (Level 1 and Level 2) with self-encrypting drives and use any type of drives with software-based encryption.
- Meet governance, risk, and compliance requirements with security features such as disk sanitization, logging and auditing monitors, and secure multitenancy.

Power your applications with abundant performance

NetApp ASA arrays are primed to take on any SAN workloads. Multitasking is not a problem. These systems maintain consistent high performance even while encrypting, compressing, deduplicating, and protecting your data.

Build a trusted SAN environment with powerful ASA systems that:

- Support both NVMe/FC and NVMe/TCP, providing latency as low as 100 microseconds and millions of IOPS in a cluster.
- Accelerate your VMware infrastructure and your Oracle, SAP, and Microsoft SQL Server applications.
- Meet performance objectives for all your applications even while efficiently encrypting, replicating, and storing data.

Simplify operations and reduce TCO

Managing your infrastructure shouldn't be complex. As seasoned veterans in this industry, we know a thing or two about what works and what doesn't. The new NetApp ASA offers an intuitive user experience. And feature-rich, SAN-specific NetApp ONTAP® data management capabilities are built in, enabling your staff to:

- Quickly provision storage and simplify ongoing management of dedicated SAN workloads—VMware, Oracle, SAP, Microsoft SQL Server.
- Streamline data management for your SAN workloads with simple, purpose-built block storage powered by ONTAP.
- Significantly reduce your storage footprint, power consumption, and carbon footprint with high-density, highly efficient all-flash storage.

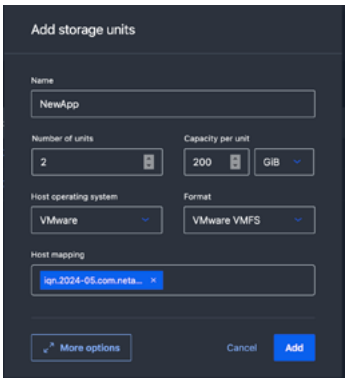

Figure 1) Provision new storage in seconds.[3]

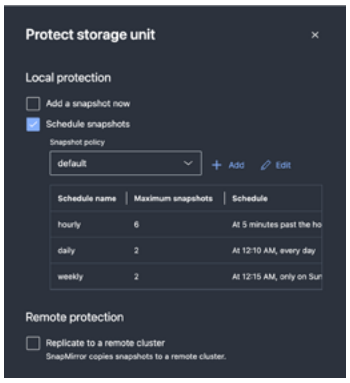

Figure 2) Protect storage unit with one click.[3]

Future-proof your infrastructure

When you purchase NetApp ASA storage, you can future-proof your investment with our industry-leading storage ownership program. Make the smart choice today and stay current with technological innovations.

- Eliminate the headache of tech refreshes with the Storage Lifecycle Program: Get a new controller every 3 years with support-managed updates included, or move to the cloud, whichever best meets your needs.
- Achieve high performance while minimizing storage cost with the Storage Efficiency Guarantee[1]: If we don't meet your workload goals, we'll make it right at no cost to you (4:1 for SAN workloads).
- Enjoy a Six Nines (99.9999%) Data Availability Guarantee[1]: If you have unplanned downtime in excess of 31.56 seconds per year, we provide remediation.
- Recover data with the Ransomware Recovery Guarantee[1]: If you can't recover your data copies with help from NetApp or partner assistance, NetApp will offer compensation.

Eliminate the headache of tech refreshes with the Storage Lifecycle Program: Get a new controller every 3 years with support-managed updates included, or move to the cloud, whichever best meets your needs.

Learn more

Flexibly consume storage resources

Like the rest of the NetApp portfolio, ASA systems are available via traditional capex or as a service with NetApp Keystone.® Gain financial flexibility as you modernize, and better align IT expenditure to business needs.

Leverage ONTAP One for SAN

Take advantage of ONTAP One for SAN, a comprehensive software suite that includes SAN protocols as well as ONTAP technologies applicable to SAN workloads, such as SnapRestore®, SnapMirror, SnapCenter, FlexClone®, FlexCache®, FPolicy, encryption[2], SnapLock®, and multitenant key management.

Footnote:

[1] Terms and conditions will apply.

[2] Encryption availability subject to Global Trade Compliance.

[3] Currently available for new ASA A-Series.

Table 1. ASA A-Series technical specifications

	ASA A1K	ASA A90	ASA A70	ASA A50	ASA A30	ASA A20
System						
Base enclosure form factor	2×2U modular	4U	4U	2U	2U	2U
Base eclosure drive count	Requires NS224	48	48	24	24	24
Power consumption (median)	2718W (with NS224)	1950W	1232W	512W	495W	432W
Scale up/per HA-pair						
Max. drive count (NVMe)	240	240	240	120	72	48
Max. raw capacity	2.67 PB	2.67 PB	2.67 PB	1.8 PB	1.1 PB	734 TB
Max. effective capacity[1]	11.6 PB	11.6 PB	11.6 PB	8 PB	4.8 PB	3.2 PB
Supported NVMe drives	1.92TB, 3.84TB, 7.68TB, 15.3TB	1.92TB, 3.84TB, 7.68TB, 15.3TB	1.92TB, 3.84TB, 7.68TB, 15.3TB	1.92TB, 3.84TB, 7.68TB, 15.3TB	1.92TB, 3.84TB, 7.68TB, 15.3TB	1.92TB, 3.84TB, 7.68TB, 15.3TB
Scale out / per cluster						
Cluster nodes	12 Nodes (6 HA Pair)	12 Nodes (6 HA Pair)	12 Nodes (6 HA Pair)	12 Nodes (6 HA Pair)	8 Nodes (4 HA Pair)	6 Nodes (3 HA Pair)
Max. raw capacity	16 PB	16 PB	16 PB	11 PB	4.4 PB	2.2 PB
Max. effective capacity[1]	69 PB	69 PB	69 PB	48 PB	19 PB	9.6 PB
IO connectivity						
PCIe expansion slots	18	18	18	8	8	8
Max. FC ports	56	56	56	24	24	24
FC port speeds	Up to 64 Gbps	Up to 64 Gbps	Up to 64 Gbps	Up to 64 Gbps	Up to 64 Gbps	Up to 64 Gbps
Max. Ethernet ports	56	56	56	32	32	32
Max. Ethernet speed	Up to 200 Gbps	Up to 200 Gbps	Up to 200 Gbps	Up to 100 Gbps	Up to 100 Gbps	Up to 100 Gbps
Shelves	NS224 (2U, 24 drives, 100Gbps NVMe)	NS224 (2U, 24 drives, 100Gbps NVMe)	NS224 (2U, 24 drives, 100Gbps NVMe)	NS224 (2U, 24 drives, 100Gbps NVMe)	NS224 (2U, 24 drives, 100Gbps NVMe)	NS224 (2U, 24 drives, 100Gbps NVMe)
Storage networking supported	NVMe/TCP, NVMe/FC, FC, iSCSI	VMe/TCP, NVMe/FC, FC, iSCSI	VMe/TCP, NVMe/FC, FC, iSCSI	VMe/TCP, NVMe/FC, FC, iSCSI	VMe/TCP, NVMe/FC, FC, iSCSI	VMe/TCP, NVMe/FC, FC, iSCSI
OS version	ONTAP 9.16.0 GA or later	ONTAP 9.16.0 GA or later	ONTAP 9.16.0 GA or later	ONTAP 9.16.1 or later	ONTAP 9.16.1 or later	ONTAP 9.16.1 or later
Host/client OS supported	Windows Server, Linux, Oracle Solaris, AIX, HP-UX, VMware, macOS, ESX	Windows Server, Linux, Oracle Solaris, AIX, HP-UX, VMware, macOS, ESX	Windows Server, Linux, Oracle Solaris, AIX, HP-UX, VMware, macOS, ESX	Windows Server, Linux, Oracle Solaris, AIX, HP-UX, VMware, macOS, ESX	Windows Server, Linux, Oracle Solaris, AIX, HP-UX, VMware, macOS, ESX	Windows Server, Linux, Oracle Solaris, AIX, HP-UX, VMware, macOS, ESX

Technical specifications for previous ASA A-Series models.

[1] Effective capacity based on 5:1 storage efficiency ratios with the maximum number of SSDs installed; space savings will vary depending on workload and use cases.

Table 2. ASA C-Series technical specifications

	ASA C800	ASA C400	ASA C250
System			
Controller form factor	4U	4U+2U external shelf	2U
Base eclosure drive count	48	Requires external shelf NS224	24
Power consumption (median)	1463W	1240W (with NS224)	491W
Scale up/per HA-pair			
Max. drive count (NVMe)	240	96	48
Max. raw capacity	7.4PB	2.9PB	1.5PB
Max. effective capacity[1]	29.5PB	11.8PB	5.9PB
Supported NVMe drives	15.3TB, 30.7TB	No internal drives Storage shelf: 15.3TB, 30.7TB	15.3TB, 30.7TB
Scale out / per cluster			
Cluster nodes	12 Nodes (6 HA Pair)	12 Nodes (6 HA Pair)	12 Nodes (6 HA Pair)
Max. raw capacity	44.2PB	17.7PB	8.8PB
Max. effective capacity[1]	176.8PB	70.7PB	35.4PB
IO connectivity			
PCIe expansion slots	10	10	4
Max. FC ports	32	40	16
FC port speeds	32 Gbps	32 Gbps	32 Gbps
Max. Ethernet ports	32	32	20
Max. Ethernet speed	Up to 100 Gbps	Up to 100 Gbps	Up to 100 Gbps
Shelves	NS224 (2U, 24 drives, NVMe QLC SSDs)	NS224 (2U, 24 drives, NVMe QLC SSDs)	NS224 (2U, 24 drives, NVMe QLC SSDs)
Storage networking supported	NVMe/TCP, NVMe/FC, FC, iSCSI	NVMe/TCP, NVMe/FC, FC, iSCSI	NVMe/TCP, NVMe/FC, FC, iSCSI
OS version	ONTAP 9.13.1 P1 or later	ONTAP 9.13.1 P1 or later	ONTAP 9.13.1 P1 or later
Host/client OS supported	Windows Server, Linux, Oracle Solaris, AIX, HP-UX, VMware, macOS, ESX	Windows Server, Linux, Oracle Solaris, AIX, HP-UX, VMware, macOS, ESX	Windows Server, Linux, Oracle Solaris, AIX, HP-UX, VMware, macOS, ESX

[1] Effective capacity based on 5:1 storage efficiency ratios with the maximum number of SSDs installed; space savings will vary depending on workload and use cases.

Table 3. ASA software

Data access protocols	• FC, iSCSI, NVMe/FC, NVMe/TCP
High availability	• Active-active controller architecture • Symmetric active-active FCP, iSCSI, and NVMe multipathing • Nondisruptive maintenance, upgrade, and scale-out clustering • Multisite resilience for continuous data access
Storage efficiency	• Inline data compression, deduplication, and compaction • Space-efficient cloning • NVMe deallocate for block space reclamation with Virtual Machines (VMs)
Data management	• Intuitive on-board GUI, REST APIs, and automation integration • AI-informed predictive analytics and corrective action • Quality of service (QoS) workload control • Easy provisioning and data management from market-leading host operating systems, hypervisors, and application software
Data protection	• Application-consistent NetApp® Snapshot™ copies for backup and restore • Integrated remote backup and disaster recovery • Synchronous zero-data-loss replication • Tamperproof Snapshot copies • Symmetric active-active multisite replication for business continuity
Security and compliance	• Multifactor admin access • In-flight and data-at-rest encryption • Regulatory-compliant data retention • Multi-admin verification before executing sensitive commands

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Whether you're planning your next-generation data center, need specialized know-how for a major storage deployment, or want to optimize the operational efficiency of your existing infrastructure, NetApp Professional Services and NetApp certified partners can help.

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NetApp

1 NetApp Data Reduction Technologies: Deduplication, Compression, and Compaction

Storage efficiency enables you to store the maximum amount of data in the smallest possible space and at the lowest cost. NetApp storage efficiency technologies are key to achieving data consolidation and managing future data growth while saving time and money.

Data storage is the largest and fastest growing IT expense incurred by businesses today. The NetApp® portfolio of storage efficiency technologies provides the ability to store the maximum amount of data for the lowest possible cost.

NetApp deduplication, data compression, and data compaction are the key components to delivering superior performance, scale, resource efficiency, and portability across multiple applications and storage tiers. No additional purchases are required to take advantage of the benefits that NetApp technologies deliver. They are:

- Free, no licence is required to enable and use deduplication
- Transparent to applications
- Lossless/zero data loss
- Supported both as inline operations and post-process operation

NetApp Deduplication

With NetApp deduplication, you can store just one copy of each unique data object, which reduces capacity requirements substantially. Deduplication automatically removes duplicate data blocks on a 4KB level across an entire volume and across volumes within an aggregate, reclaiming wasted storage to achieve significant space savings.

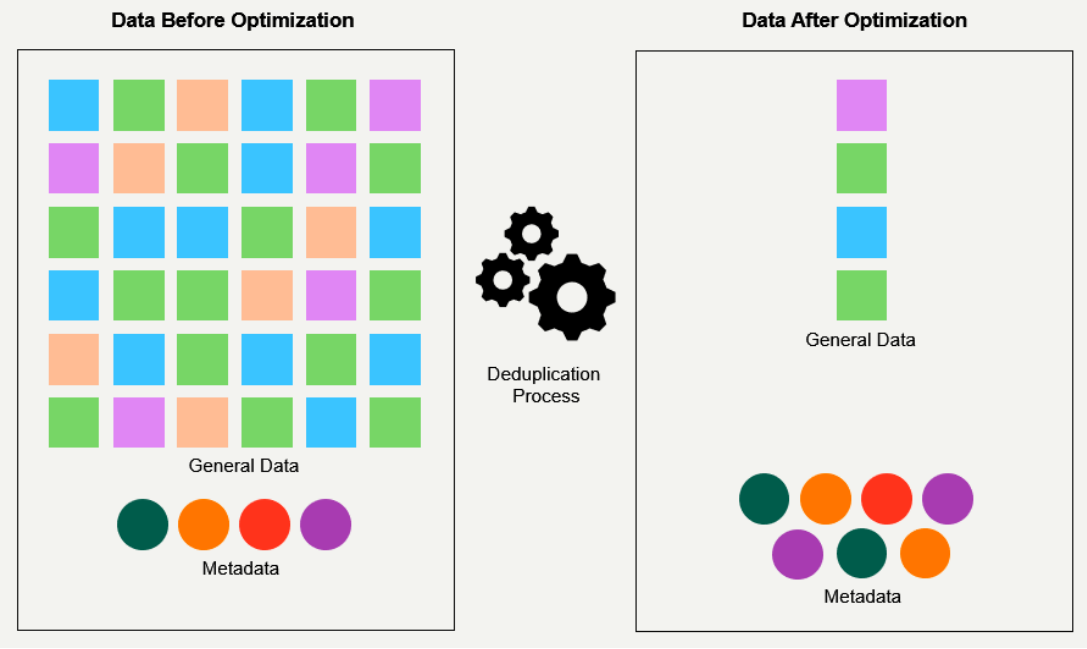

Figure 1: NetApp deduplication removes duplicate data blocks.

NetApp deduplication can be implemented across a wide variety of applications and file types, including:

- Primary data volumes
- Data backup
- Data archiving

NetApp deduplication can help you reclaim up to 95% of storage space, depending on application and file type.

There are two main deduplication methods: In-line and post-process deduplication. Inline deduplication provides immediate space savings; post-process deduplication first writes the blocks to disk and then dedupes the data at a scheduled time.

- **Inline deduplication**: For copy offload and VDI deployments. It's especially useful for VM patch apply use cases, VM provisioning, and database migrate operations that result in many duplicate blocks in memory that can be eliminated by inline dedupe.
- **Post-process deduplication**: When inline deduplication is not preferable; for example, for entry-level systems in which memory is limited to meeting client I/O SLAs. In general, NetApp does not recommend deduplication for use cases in which data is overwritten at a rapid rate.

NetApp Data Compression

NetApp data compression is a software-based solution that provides transparent data compression. It gives the ability to store more data in less space. You can use data compression to reduce the time and bandwidth required to replicate data during volume SnapMirror® transfers. Data compression saves space on regular files or LUNs.

Data compression works by compressing a small group of consecutive blocks known as a compression group. It can be run inline or postprocess and includes the capability to compress existing data. No application changes are required to use NetApp data compression. This process is enabled and managed by using a simple CLI or GUI such as System Manager or NetApp Active IQ Unified Manager.

As with our deduplication process, there are two main data compression methods: In-line and post-process compression. Inline compression provides immediate space savings; post-process compression first writes the blocks to disk as uncompressed and then at a scheduled time compresses the data.

- **Inline compression:** For customers who are not as performance sensitive and can handle some impact on new write performance as well as on CPU during peak hours. This type of compression is also useful for customers who want to minimise $/gigabyte and the PE cycle of SSD drives to prolong the life of flash media. Common use cases under this category are primary and secondary workloads on AFF and Flash Pool configurations and secondary workloads on all HDD configurations.
- **Post-process compression**: For environments in which you want compression savings but don't want to incur a performance penalty associated with new writes. Common use cases under this category are primary workloads on all HDD configurations.

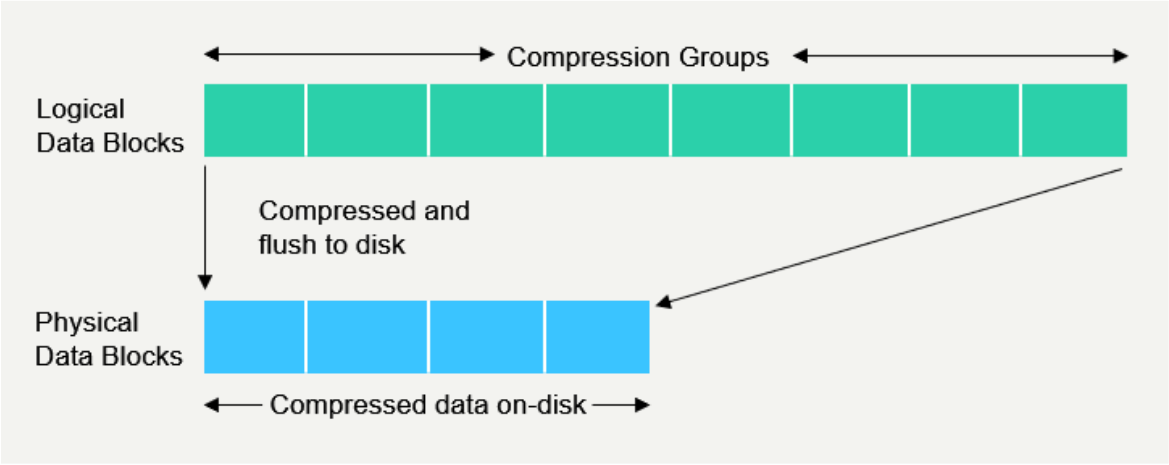

Figure 2: Compression groups are tested for compressibility before any compression takes place *– They are then flushed to disk, compressed or uncompressed, depending on the results of the test.*

NetApp Data Compaction

Compaction gives you the ability to further reduce the physical used space needed to store data. It's an inline operation and occurs after inline compression and inline deduplication. Data compaction happens on logical blocks as they are organised before being written to storage. It takes I/Os that normally consume a 4K block each on physical storage, and packs multiple I/Os into one physical 4K block.

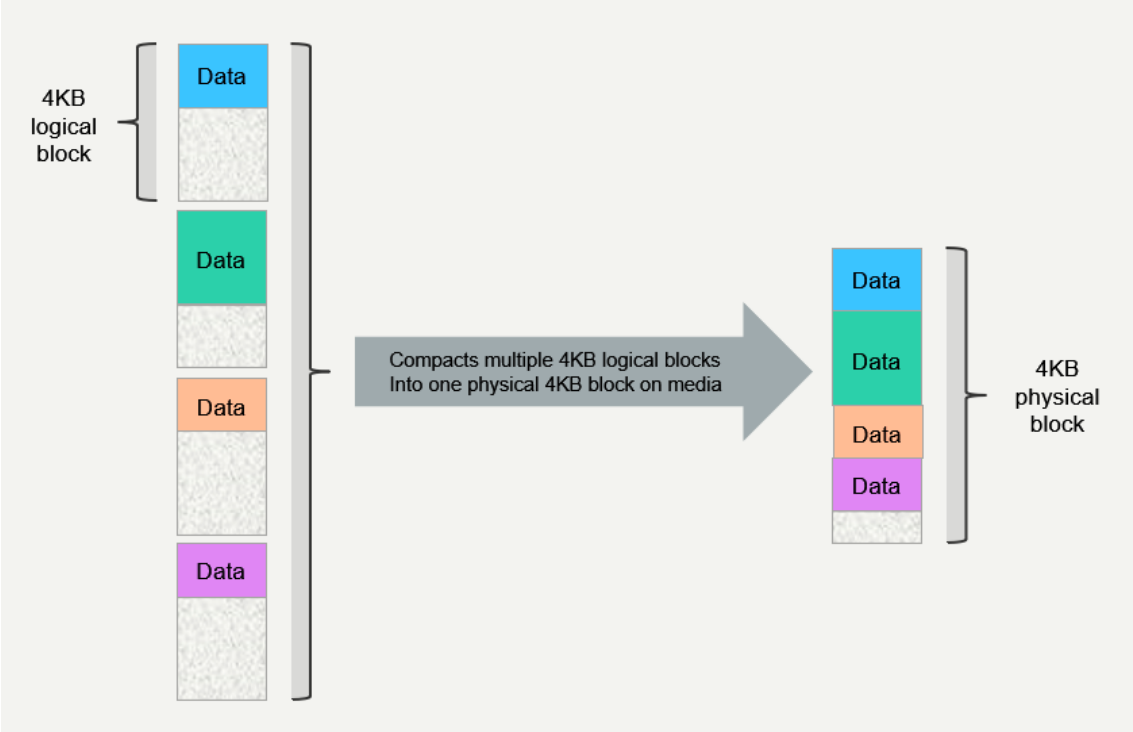

Figure 3: How data compaction works.

Compaction is enabled by default for NetApp All Flash FAS systems. It is an optional feature that can be turned on for FAS systems, with either HDD-only aggregates or NetApp Flash Pool™ aggregates. Compaction is a significant addition to our storage efficiency portfolio and complements NetApp's superior deduplication and compression technologies.

Space Savings

The table below lists the storage efficiency data reduction ratio ranges for different applications. A combination of synthetic datasets and real-world datasets has been used to determine the typical savings ratio range. The savings ratio range mentioned are only indicative.

Table 1: Typical savings ratios with ONTAP 9—Sample savings achieved with internal and customer testing[1].

Typical Savings Ratios with ONTAP 9	
Workload [with deduplication, data compaction, adaptive compression and FlexClone volumes (where applicable) technologies]	**Ratio Range**
Home directories	1.5:1.-.2:1
Software development	2:1 - 10:1
VDI VMware Horizon full clone desktops (persistent) – NetApp Clones	6:1 - 10:1
VDI VMware Horizon linked clone desktops (nonpersistent)	5:1 - 7:1
VDI Citrix XenDesktop full clone desktops (persistent) – NetApp Clones	6:1 - 10:1
VDI Citrix XenDesktop MCS desktops (nonpersistent)	5:1 - 7:1
VDI Citrix Provisioning services desktops (nonpersistent)	3.3:1 - 5:1
Virtual Servers (OS and Applications)	2:1.-.4:1
Oracle databases (with no database compression)	2.1 - 4:1
SQL 2014 databases (with no database compression)	2.1 - 4:1
Microsoft Exchange	1.6:1
Mongo DB	1.3:1 - 1.5:1
Precompressed data (such as video and image files, audio files, pdfs, etc.)	No Savings

Talk to your account representative on how to estimate savings for the data residing on non-NetApp systems.

[1] Actual customer savings will depend on data type and data layout.

1 ONTAP ONE: A SINGLE ONTAP SOFTWARE SUITE

ONTAP One is a comprehensive intelligent data management suite. It provides all the functionality of ONTAP in one convenient bundle. By including all available NetApp ONTAP software, ONTAP One gives you the ability to easily activate and utilize any of the powerful capabilities offered by ONTAP.

NetApp® ONTAP® One is a comprehensive intelligent data management suite. It is managed through the BlueXP™ unified control plane and has all available ONTAP-licensed functionality. ONTAP One combines the contents of the previous ONTAP bundles: Core bundle, Data Protection bundle, Security and Compliance bundle, Hybrid Cloud bundle, and Encryption bundle.

ONTAP ONE: YOUR COMPLETE STORAGE SERVICE

NetApp has simplified the purchase and deployment of ONTAP systems by building the most comprehensive set of enterprise storage services with every system. ONTAP One is included on every AFF (A-Series and C-Series), All-SAN Array (ASA), and FAS system. Each ONTAP-based hardware platform from NetApp now has a simple, easy-to-buy, easy-to-consume software scheme. One line item on quotes, one price, no add-ons or complexities—it's as simple as it gets.

ONTAP One encompasses all the core ONTAP multiprotocol features of NetApp unified storage. It includes all protocols (SAN/NAS/Object) and ONTAP technologies such as SnapRestore®, SnapMirror®, SnapCenter®, FabricPool (to ONTAP-S3 and StorageGRID®), FlexClone®, FlexCache®, FPolicy, Encryption, autonomous ransomware protection, SnapLock®, and multi-tenant key management. It also includes leading solutions for data protection, anti-ransomware, and hybrid cloud.

With ONTAP One, you can:

- Simplify the buying and operational experience with all-in-one software license
- Easily replicate and backup your data
- Defend against ransomware and cyber-attacks

SIMPLIFY THE BUYING AND OPERATIONAL EXPERIENCE WITH ALL-IN-ONE LICENSE

With ONTAP One, you can access NetApp's robust suite of security features and all the capabilities offered by ONTAP without any licensing barriers. This all-in-one software license simplifies the buying and operational experience for NetApp customers.

NetApp storage systems are ideal for building efficient, scalable, secure, and cloud-connected on-premises infrastructures while reducing total cost of ownership (TCO). With ONTAP One, you can activate and utilize any powerful ONTAP capabilities.

All new and existing FAS, AFF, and ASA systems licensed with anything more than the bare minimum can now get licenses for everything ONTAP. This means that if you have existing FAS, AFF, or ASA systems licensed with Flash, Core+DP, or Premium, you are now entitled to convert to ONTAP One licensing at no additional cost.

ONTAP One includes all of the features of ONTAP, including:

- Data protection
- Disaster recovery
- High availability
- Cloud integration
- Storage efficiency
- Performance
- Security

ONTAP One includes all on-premises ONTAP license keys. However, it doesn't include cloud-delivered services like BlueXP Tiering, Cloud Insights, BlueXP Backup, or Data Governance.

For customers who don't require all of the features in ONTAP One, NetApp also offers ONTAP Base. ONTAP Base is an optional software suite for ONTAP systems as an alternative to ONTAP One. It is for specific use cases where data protection technologies such as SnapMirror and SnapCenter and security features like Autonomous Ransomware are not required, as in non-production systems for dedicated test/dev environments.

EASILY REPLICATE AND BACKUP YOUR DATA

ONTAP One includes leading replication software with NetApp SnapMirror and SnapMirror S3. With SnapMirror Cloud, you can back up easily and tier to the cloud. ONTAP One provides application-integrated data protection with SnapCenter, integrated autonomous ransomware protection, and primary storage compliance with NetApp SnapLock.

Since ransomware poses significant costs to companies annually, protecting, detecting, and recovering from ransomware is crucial for business continuity. Combining integrated autonomous ransomware protection with tamper-proof NetApp Snapshot™ copies (enabled by SnapLock) provides the industry's best method to keep your data safe and recover from ransomware.

DEFEND AGAINST RANSOMWARE AND CYBER-ATTACKS

Data protection and defending against ransomware and cyber-attacks are critical for today's storage environments and should be implemented by all businesses. NetApp includes all these capabilities in ONTAP One so that you can benefit from ONTAP's industry-leading technology.

Solve your storage challenges and reduce TCO with:

- Data protection and continuous availability, leveraging more than 30 years of experience supporting our customers.
- Ransomware protection and security, including over 30 security features, with autonomous detection and protection against ransomware attacks before you even know there's a threat.
- Ransomware Recovery Guarantee available on all newly purchased AFF (A-Series and C-Series), ASA, and FAS storage systems.
- Storage efficiency, backed by a 4:1 guarantee for SAN workloads.
- Nondisruptive cluster scaling with up to 106PB of effective capacity.
- Automation, hybrid cloud connectivity, and data tiering.

Table 1: ONTAP One for SAN.

ASA SERIES SYSTEMS
NetApp Volume Encryption
Trusted Platform Module
Data at Rest Encryption
SnapMirror Cloud
SnapMirror (Async/Sync/activesync)
SnapCenter
Multi-Tenant Key Manager
SnapLock
FlexClone
SnapRestore
FC, ISCSI
NVMe-oF